ESTABLISHED 1916
as The OIL WEEKLY

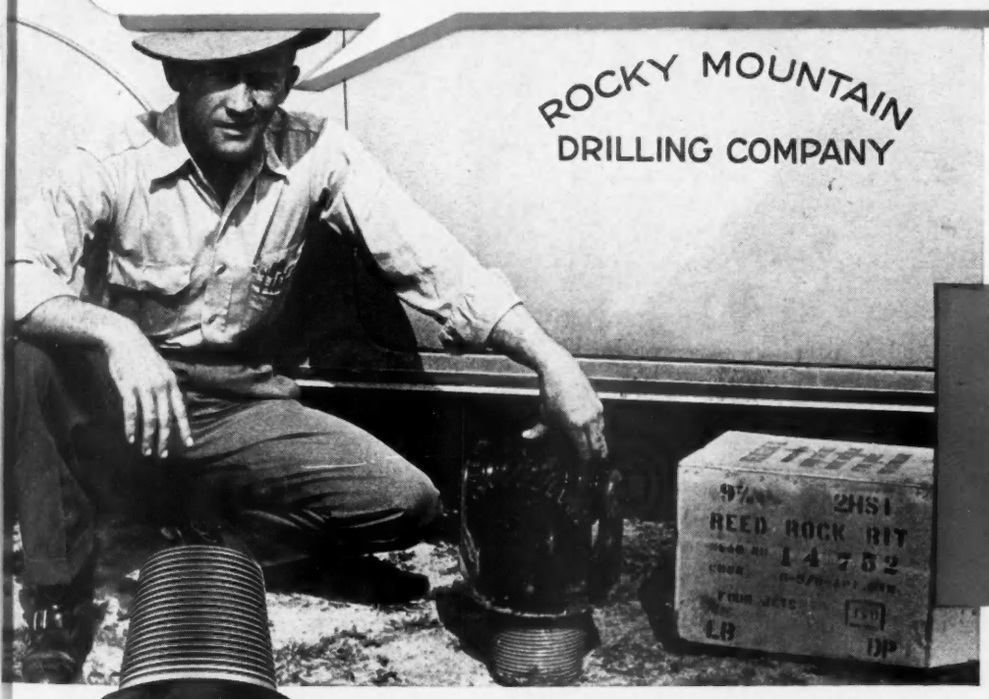
WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING, PRODUCING, PIPE LINE OPERATIONS AND MANAGEMENT

Subscription Price, $2 Per Year — JULY 1, 1951 — Price This Copy, 50 Cents

EAST ENGIN. LIBRARY

I like this bit for hard, abrasive drilling



... says H. A. Stripling, tool pusher in California for the Rocky Mountain Drilling Co.

REED
Liquid-blast
ROCK BITS

"I run **REED** 2HS-1 Rock Bits in hard, abrasive formations because I can depend on getting fast drilling and good footage. They can't be beat for hard-formation drilling.

"At best, hard formations are expensive to drill, but I find that **REED** 2HS-1 Bits help me keep costs down."

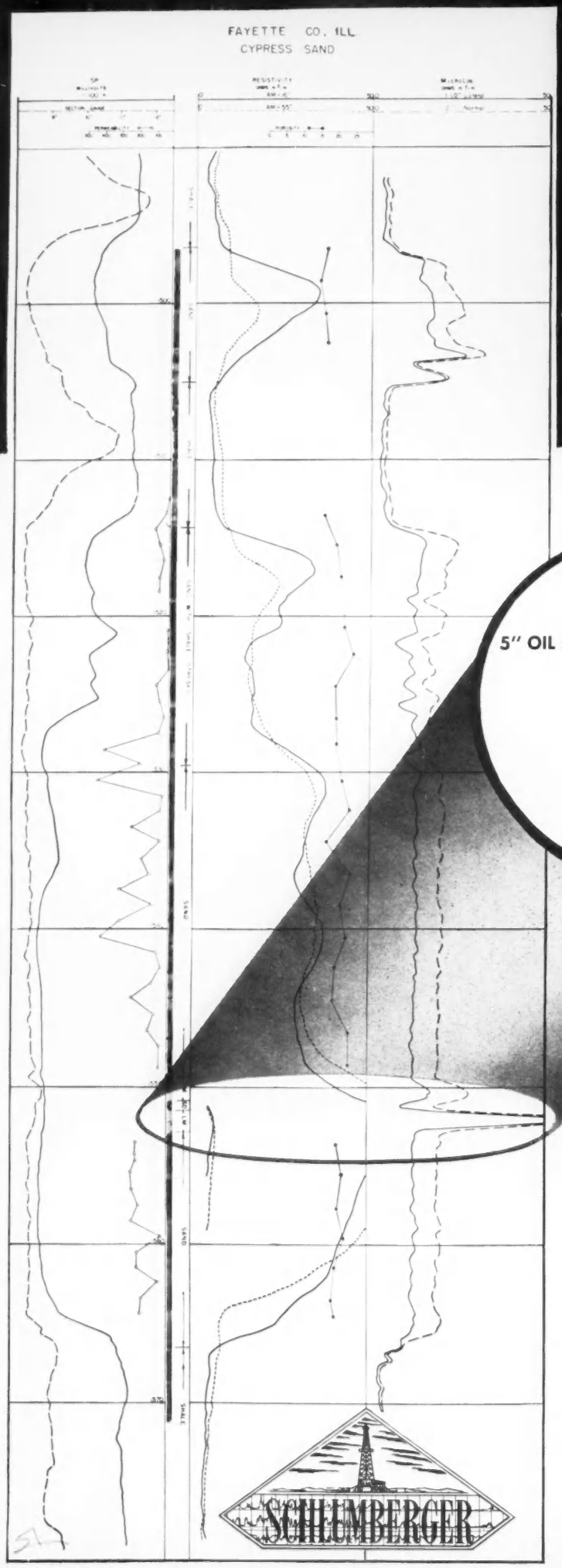
For good long runs use the **REED** *"LB"*

REED ROLLER BIT COMPANY
HOUSTON 1, TEXAS
Gulf Coast, Mid-Continent, Rocky Mountain and Canadian Distributor for Martin-Decker Products

THE MARK OF QUALITY

2917

PHOTOGRAPHS OF CORES PROVE MICROLOG DETAIL



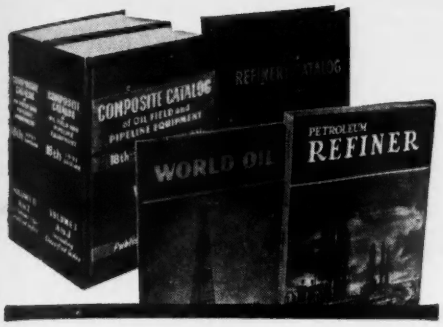
The Microlog records the restivities of micro-volumes of formation along the face of the bore hole. For this reason it gives precise lithological detail. It indicates with equal precision those formations which are permeable and porous enough to have reservoir possibilities.

Actual photographs of cores reproduced here substantiate Microlog detail. A Microlog recorded in the cypress sand, Louden Field, Illinois, has been expanded to fit photographs of the cored section. The resulting record is an interesting study in formation detail which cannot be duplicated by any other logging method.

Porosity and permeability records are also reproduced. The correlation between these measurements and the Microlog values confirm the ability of the Microlog to indicate the producing horizon with amazing detail.

SCHLUMBERGER WELL SURVEYING CORP.

HOUSTON, TEXAS



E. Engin Dirdt

EAST ENGINI LIBRARY
TN
860
.043

Specialized Oil Publications of
THE GULF PUBLISHING COMPANY
3301 Buffalo Drive, Houston 6, Texas
Box 2608, Houston 1, Texas
WORLD OIL and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry
PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

RAY L. DUDLEY, *President, Publisher*
A. L. BURNS, *General Manager*
WARREN L. BAKER, *Editorial Director*

EDITORIAL STAFF

WARREN L. BAKER, *Editor*
AL REESE, *Managing Editor*
L. J. LOGAN, *Associate Editor*
CECIL W. SMITH, *Statistical Editor*
J. E. KASTROP, *Production Editor*
W. B. COLVIN, *Drilling Editor*
DONALD M. TAYLOR, *Pipe Line Editor*
DON KLIEWER, *International Editor*

DISTRICT EDITORS

ROBERT E. SPANN, 250 Park Ave., New York 17, N. Y.
GILBERT M. WILSON, W. W. Wilson Bldg., Huntington Park, Calif.
ANTHONY GIBBON, Hunt Bldg., Tulsa 3, Okla.
MARION DENNARD RUTH THOMPSON
Editorial Assistants
MARY A. ZUBER, *Librarian*

ADVERTISING STAFF

TOM W. NELSON, *Advertising Manager*
ROGER MOTHERAL, *Eastern Advertising Manager*
250 Park Ave., New York 17, N. Y.
NELSON BIGELOW, 250 Park Ave., New York 17, N. Y.
BILL WESTFALL, 1010 Euclid Ave., Cleveland 15, Ohio
H. G. FITZPATRICK MARTIN HALLORAN
332 S. Michigan Ave., Chicago 14, Ill.
BILL ATCHESON, Hunt Bldg., Tulsa 3, Okla.
J. W. CURTS, W. W. Wilson Bldg., Huntington Park, Calif.
CHARLES WYATT DOUG CRAIG
3301 Buffalo Drive, Houston 6, Texas

CIRCULATION DEPARTMENT

R. M. DE SOMBRE, *Manager*

Single copies 50 cents (except special issues). Subscription price: domestic and foreign, $2 a year; 2 years, $3; 3 years, $4. WORLD OIL, published every month except semi-monthly in February and July. Entered as *The Oil Weekly* as second class mail matter December 23, 1916, at the post office at Houston, Texas, under the act of March 3, 1879. Advertising rates on application. Copyright, 1951, by The Gulf Publishing Company.

Indexed by Industrial Arts Index and Engineering Index

Turn to Page 295

for information about our new International Operations issue. If you are not a regular reader of WORLD OIL, use the coupon on page 295 to get your copy of this important special issue.

ABC WORLD OIL HBP
Established 1916 as THE OIL WEEKLY ®

CONTENTS

July 1, 1951 **Vol. 133, No. 1**

CURRENT OUTLOOK SECTION

Looking Ahead ... 35
Editor's Page — *Warren L. Baker* ... 37
The Changing Panorama ... 39
Report from the Observatory — *Ray L. Dudley and Warren L. Baker* ... 40
Petroleum Trends — *Cecil W. Smith* ... 42
Monthly News Analysis ... 44
The Month's Completions ... 50
Safety Program Can Promote Multiple Benefits — *D. M. Farrell* ... 55
Materials Control Practices — *J. L. Stackpole* ... 61
Safety Record Best in Industry History ... 66
Improved Proration Would Expand Reserves — *Park Jones* ... 68
Texas Research Center Aids Oil Industry — *Fred D. Thompson* ... 69

EXPLORATION SECTION

Significant Developments in the Four Corners Area — *J. L. Tatum* ... 73
Williston Basin Oil Possibilities — *G. Wendell Smith* ... 78
Discovery Heightens Interest in North Dakota Geology (Last of Two Parts) — *Dr. Wilson M. Laird* ... 83
Exploration Sets All-Time Record ... 88
New Oil, Distillate and Gas Discoveries and Extensions During May ... 90

DRILLING SECTION

Unitized Mud Pumps Increase Flexibility — *A. W. Shaw* ... 107
WORLD OIL Graphics: Drill Collar Care ... 112
A Review of Casing String Design, Principles and Practice (First of Two Parts) — *J. O. Hills* ... 113
Water Tank Makes Engine Foundation — *Gilbert M. Wilson* ... 124
The Effect of Mud Filtrates and Mud Particles upon the Permeabilities of Cores (First of Two Parts) — *T. J. Nowak and R. F. Krueger* ... 125
New Fishing Technique Developed for Wire Line Devices — *R. R. Rieke* ... 132
Time-Dependent Strains Around Uncased Holes — *A. D. Topping* ... 134
How to Do It—Drilling Hints ... 141

PRODUCTION SECTION

Value of Agents to Control Silicate Swelling in Acidizing — *Dr. Paul H. Cardwell* ... 159
Quantitative Log Interpretation of the San Andres Dolomite — *C. B. Scotty* ... 166
Drilling and Completion Practices in the Church Buttes Field — *W. C. Dinger* ... 178
Measurement and Use of Relative Permeability Data — *Uzzell S. Branson, Jr.* ... 184
Corrosion Fundamentals in Field Application — *Dr. Alfred N. Chatenever* ... 194
How to Do It—Production Hints ... 202

PIPE LINE SECTION

Submerged Arc Unit Welds Pipe Line on Right-of-Way — *C. A. Renton* ... 211
Station Automatically Heats and Ships Crude, Telemeters Data — *Gilbert M. Wilson* ... 213
38-Year-Old Pipe Reclaimed — *James Joseph* ... 220
Engine Valve Failures and Remedies — *A. L. Pomeroy* ... 224
Pipe Line Construction — *Cecil W. Smith* ... 230
How to Do It—Pipe Line Hints ... 232

INTERNATIONAL SECTION

Boom in Venezuela — *Robert E. Spann* ... 239
Kingdoms of Oil: El Dorado, Ark. — *Anthony Gibbon* ... 242
Failure of Iran Talks Perils Supply-Demand Balance ... 246
Of World Oil Men ... 248
Gas Ruling May Slow Canadian Activity ... 252
Oil Field Communications in Venezuela — *F. Vinton Long* ... 254
Aramco Report Reveals Steady Progress ... 258

OTHER DEPARTMENTS

Advertisers' Index ... 2
The Oil Man's Calendar ... 32
New and Improved Equipment Supplementing Composite Catalog ... 266
Other New and Improved Equipment ... 272
New Literature ... 276
Men in the Industry News ... 278
Companies in the News ... 286
Associations ... 287
Equipment and Service Suppliers' Notes ... 290
New Books, Maps and Movies ... 297
Squeaks from the Bullwheel ... 298

ADVERTISERS' INDEX

*Asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in current 18th (1951) edition of The Composite Catalog of Oil Field and Pipe Line Equipment.

A

*Acme Fishing Tool Co. 94
Acme Foundry & Machine Co. 270
Aero Service Corp. 249
*Aetna Ball & Roller Bearing Co. 155
*Altens Foundry & Machine Works, Inc. 269
*American Iron & Machine Works Co. 118-119
*American Locomotive Co. 85
*American Manufacturing Co. of Texas 6
*American Sand-Banum Co. 206
American Steel & Wire Co. 17
Avondale Marine Ways, Inc. 271
*Axelson Manufacturing Co. 163

B

*B & W Incorporated 286
*Baash-Ross Tool Co. 81
*Baker Oil Tools, Inc. 38 and 250-251
*Baroid Sales Division, National Lead Co. 153 and 238
Wm. M. Barret, Inc. 302
*Beaumont Iron Works Co. 85
Beaumont Well Works Co. 275
*Beaver Pipe Tools, Inc. 275
*Bethlehem Steel Co. 11, 47 and 127
*Bethlehem Supply Co. 195
*Big Four Machine & Supply Co. 90
*Black, Sivalls & Bryson, Inc. 63 and 173
The Bovaird Supply Co. 223
*S. R. Bowen Co. 275
*Bowen Company of Texas, Inc. 137
*The Brewster Co. 82
*The Buda Co. 99
Butler Manufacturing Co. 229
*Byron Jackson Co. 89 and 104

C

Cable & Stine 264
*Cameron Iron Works, Inc. 106
*Cardwell Manufacturing Co. 58- 59
*Catawissa Valve & Fittings Co. 287
Caterpillar Tractor Co. 19
*The Cavins Co. 101
Chicago & Southern Air Lines 256
*Chicago Pneumatic Tool Co. 13
*Chiksan Co. 293
*Christensen Diamond Products Co. 144
Chrysler Corp. 25
The Dan L. Clark Drilling Co. 96
Columbia Steel Co. 17
*Construction Machinery Companies 282
The Continental Supply Co. 181
Core Laboratories, Inc. 121
*Crane Co. 41
Syd E. Culbertson Co. 233
*Cummins Engine Co. 91

D

Darling Valve & Manufacturing Co. 285
*Detroit Diesel Engine Division, General Motors Corp. 8
Dowell Incorporated 36
*Dresser Industries, Inc. 65
*Drilling & Service, Inc. 147

E

The Eagle-Picher Co. 276
E. H. Edwards Co. 143
Empire Trust Co. 60
*Emsco Derrick & Equipment Co. 139-140

F

*Fairbanks, Morse & Co. 201
*Fluid Packed Pump Co. 191-192
*Foster Cathead Co. 92

G

*Gaso Pump & Burner Mfg. Co. 209
*General Motors Corp. 8
The Geolograph Co. 101
*Goodall Rubber Co. 95
The B. F. Goodrich Co. 9
*H. P. Gott Manufacturing Co. 144
*Grant Oil Tool Co. 280
*Great Lakes Carbon Corp. 156
*Grove Regulator Co. 183
*The Guiberson Corp. 169
*The Gulf Publishing Co. 271

H

*Halliburton Oil Well Cementing Co. 71
*Harrisburg Steel Corp. 260
*Hercules Tool Co. 302
*Hewitt-Robins, Inc. 291
Hinderliter Tool Company Division H. K. Porter Co. 301
Houston Contracting Co. 231
Houston Laboratories 302
*Hughes Tool Co. 237 and IV Cover
Humble Oil & Refining Co. 12
*Hutchison Manufacturing Co. 150

I

Industrial Engine Division, Chrysler Corp. 25
*International Harvester Co. 27 and 263
The International Nickel Co. 26 and 265

J

Jarecki International Supply Division, H. K. Porter Co. 185
*Jefferson Union Co. 154
*Jensen Brothers Manufacturing Co. 274
*M. O. Johnston Oil Field Service Corp. 10
Johnston Oil Field Service Corp. 273
*Joy Manufacturing Co. 97
*Justrite Manufacturing Co. 271

K

Kaiser Steel Corp. 257
Kern Directional Drilling Corp. 154
*King Oil Tools 98
*Kinzbach Tool Co. 100
*Kobe, Inc. 65

L

*L & H Machine Works 156
*Lane-Wells Company 45, 177, 247, 300 and III Cover
*Larkin Packer Co. 158
*The Layne and Bowler Co. 259
*LeBus Rotary Tool Works, Inc. 294
*LeGrand, Sutcliff & Gell, Ltd. 197
A. Leschen & Sons Rope Co. 103
Levingston Shipbuilding Co. 262
Leyman Manufacturing Corp. 281
*Link-Belt Co. 3
*A. M. Lockett & Co. 279
*Lone Star Tool Co. 152
Lubbock Machine Co. 234
*Lucey Export Corp. 253
*Lufkin Foundry & Machine Co. 33

M

Macwhyte Co. 5
*Magnet Cove Barium Corp. 117
*Jas. P. Marsh Corp. 20
*McCullough Tool Co. 299
McGowan Pump Division, The Leyman Manufacturing Corp. 281
*Mid-Continent Supply Co. 300
*Miller Sand Pump Co. 208
*Mission Manufacturing Co. 105
*Morse Chain Co. 148-149

N

National Bank of Tulsa 4
*National Lead Co. 153 and 238
*The National Supply Co. 51-52-53 and 170-171
*National Tank Co. 165
National Tube Co. 23
*New York Belting & Packing Co. 131
*Nordstrom Valve Division Rockwell Manufacturing Co. 227-228
*W. C. Norris, Manufacturer, Inc. 203
Northwestern Exploration Drilling Co. 104

O

*Walter O'Bannon Co. 298
*Oil Center Tool Co. 21 and 200
*Oil Well Manufacturing Corp. 297
*Oil Well Supply Co. 267
*Otis Pressure Control, Inc. 189

P

Pacific Coast Borax Co. 198
*Parelex Corp. 264
*Parkersburg Machine Co. 264
*The Parkersburg Rig & Reel Co. 179
*Pelican Well Tool & Supply Co. 286 and 302
*Penberthy Injector Co. 142, 204 and 268
Petroleum Distributing Co. 278
Petroleum Electric Power Association 49
*Petroleum Specialty Co. 207
Pewthers Ditcher Co. 225
Piper Aircraft Corp. 102
Pittsburgh Coke & Chemical Co. 292
H. K. Porter Co. 185 and 301
Property Credit Corp. 272

R

*Rector Well Equipment Co. 199
*Reda Pump Co. 196
*Reed Roller Bit Co. I Cover and 123
*Republic Steel Corp. 29 and 235
*The Ridge Tool Co. 289
*Rockwell Manufacturing Co. 15 and 227-228
*John A. Roebling's Sons Co. 31
*Rollway Bearing Co. 135
The Royal Bank of Canada 252

S

*S & R Tool & Supply Co. 279
Santa Fe Railway 283
*Schlumberger Well Surveying Corp. II Cover
The Second National Bank of Houston 261
Seismograph Service Corp. 77
*Shaffer Tool Works 93
Shell Development Co. 24
A. O. Smith Corp. 219
Southern Engine & Pump Co. 279
*Spang-Chalfant Division, The National Supply Co. 54 and 170-171
*Sperry-Sun Well Surveying Co. 67
Standard Oil Company of California 30
*Standco Brake Lining Co. 94 and 302
*Stitt Ignition Co. 278
*Sunshine Iron Works 288
Superior Iron Works & Supply Co. 175

T

*Technical Oil Tool Corp. 72
*Templeton, Kenly & Co. 154
The Texas Company 14
Texas Electric Steel Casting Co. 277
*The Thermoid Co. 145
*Thompson Tool Co. 146
*Thornhill-Craver Co. 217
The Torrington Co. 28
Trading Post 296
Trans-Texas Airways 236
*Tretolite Co. 157
Trojan Construction Co. 234
*Tuboscope Co. 205

U

*Union Wire Rope Corp. 87
United States Steel Corp. 17, 23, 34 and 267
United States Steel Export Co. 17 and 23
*Universal Atlas Cement Co. 34

V

Varner Co. 258
*Victaulic Company of America 32
*Visco Products Co. 7

W

*W-K-M Company, Inc. 215
*Walker-Neer Machine Co. 18
Warren Automatic Tool Co. 94
*Waukesha Motor Co. 16
Waukesha Sales & Service Co. 151
Welex Jet Services, Inc. 115
*Well Equipment Mfg. Corp. 284
Westinghouse Air Brake Co. 101
*Whitney Chain Co. 22
Wichita Tool Repair Co. 156
*Wilson Manufacturing Co. 111
*Wilson Supply Co. 186-187
*Wisconsin Motor Corp. 206
World Oil 295
*Worthington Pump & Machinery Corp. 129

Y

The Youngstown Sheet & Tube Co. 210

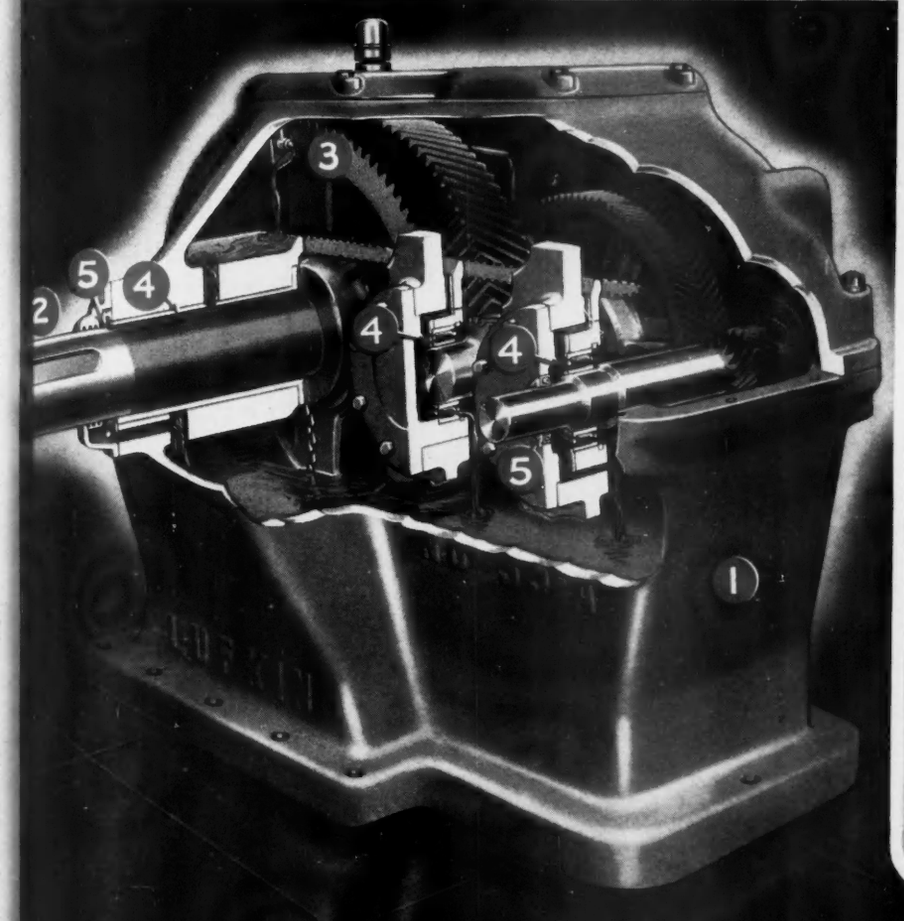
WORLD OIL

CURRENT OUTLOOK SECTION

AND NEWS ANALYSIS

L. J. LOGAN, SECTION EDITOR

The Lufkin GEAR BOX LUBRICATION SYSTEM



The heart of an oil field pumping unit is the gear reducer. Pumping service is generally considered to be one of the toughest applications for gears. Lufkin's total output of gear reducers in this class is now over thirty thousand units. Here are the reasons Lufkin is still first in oil field reducers:

1. The Lufkin reducer housings are of rugged construction and especially built for oil well service.

2. All shafts are forged from alloy steel which is heat treated and precision ground.

3. Gears which are precision cut on our Sykes Herringbone machines are used exclusively in Lufkin Units. These gears operate in an oil bath with gear wipers to flood the bearings.

4. Lufkin uses oversize bronzoid bearings on crankshafts and the crankshaft is held rigid by hub plates on the bearing. The pinions float on Hyatt Hy-Load Roller Bearings.

5. The pinion shaft bearings are equipped with patented oil seals, to prevent oil leaks; while the main crankshaft is equipped with collar oil slingers and annular grooved drain covers.

LUFKIN FOUNDRY & MACHINE COMPANY

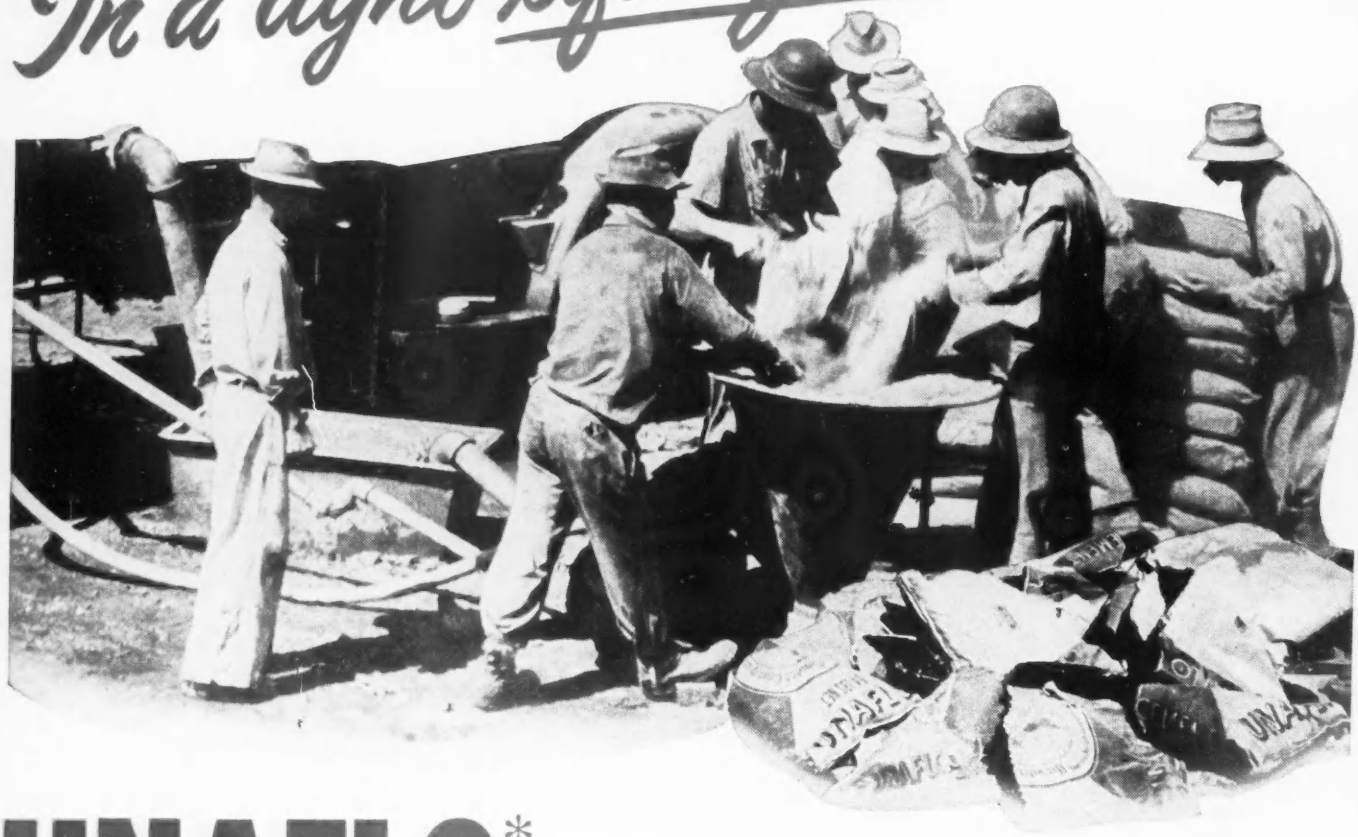
LUFKIN, TEXAS

Branch sales and service Houston, Dallas, New York, Tulsa, Los Angeles, Seminole, Oklahoma City, Corpus Christi, Odessa, Kilgore, Wichita Falls, Casper, Wyoming; Great Bend, Kansas.

Lufkin Equipment in CANADA is handled by

THE LUFKIN MACHINE CO., LTD. 14321 108th Avenue, Edmonton, Alberta, Canada.

In a tight squeeze...



UNAFLO* protects your investment 3 ways

When you need extra time on a hot, deep squeeze—even when pressures rise above 5000 p. s. i. and temperatures hit over 200°F.—that's when you can rely on easy-pumping, hard-setting Unaflo Oil-Well Cement. It protects your investment in well, tools and equipment these three ways:

1. Unaflo stays fluid and pumpable under highest bottom-hole pressures and temperatures... high initial fluidity permits using heavy slurries when needed.

2. Unaflo also has *sustained* fluidity because of its delayed, postponed, retarded set, which allows ample time, even during emergencies, to get cement in place.

3. A slurry of Unaflo hardens normally after retardation to a tight formation bond. Its seal is impermeable to all fluids, including sulfate waters.

To be sure, always protect your investment with Unaflo.

• • •

HELPFUL FREE BULLETIN gives a facts-and-figures comparison of Unaflo's well-bottom performance with other cements. For your copy write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

*"UNAFLO" is the registered trade mark of the retarded oil-well cement manufactured by Universal Atlas Cement Company

WACO • KANSAS CITY • BIRMINGHAM • CHICAGO • NEW YORK • Export Distributor: United States Steel Export Co., New York

Universal Atlas Cement Company

OIL-FIELD CEMENTS

Unaflo *Retarded* Oil-Well Cement
Resistant to Sulfate Waters
Atlas Portland Cement—Type I

Atlas Portland Cement—Type II
Resistant to Sulfate Waters
Atlas High-Early Cement—Type III

WO-U-116RR

NBC SUMMER SYMPHONY CONCERTS—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—June to September*

Looking Ahead

PETROLEUM INDUSTRY can help get steel by actively participating in current collection campaign of scrap iron. Good example for industry has been set by scrap iron collection drive in Texas, conducted by Texas Independent Producers and Royalty Owners Association.

NORTH DAKOTA'S basic conservation law, passed in 1941, is believed adequate to assure efficient and sound development of oil and gas. Following recent discovery of state's first oil field, Dr. Wilson Laird, state geologist, visited Oklahoma, Texas, Louisiana, Mississippi, and Arkansas conservation agencies, gathering information on rules, regulations, and other data that may offer helpful ideas for administering regulations in North Dakota.

TEXAS RAILROAD COMMISSION is further tightening prevention of gas waste in Texas, having undertaken to stop flaring of gas produced with oil in West Texas. Commission held hearing of West Texas oil operators in Mid-June requiring them to show cause why production should not be restricted to prevent gas flaring. Similar action in other areas in recent years has hastened construction of gas processing, cycling, pressure maintenance, and related projects that have largely eliminated gas waste in Texas.

IMPORTANCE OF LIQUEFIED PETROLEUM GAS has been recognized by enactment of a law in Texas creating a new Liquefied Petroleum Gas division of the Texas Railroad Commission to regulate distribution, storage and sale of LP gases. LPG regulation previously came under gas utilities division.

CONSTRUCTION OF OIL PIPE LINE from Alberta to the Pacific Coast is being studied by Imperial Oil Company, Ltd. More proved reserves in Alberta would make line more definitely justified, as Prairie provinces and Eastern Canada represent substantial markets for presently proved reserves. However, Alberta is almost as large in area as Texas and apparently has good possibilities of additional fields.

PRODUCTION OF PETROLEUM PRODUCTS from oil shale probably will not be commercially feasible until average price of crude oil in California reaches $3.50 per barrel, stated Reese H. Taylor, president, Union Oil Company of California. Company holds extensive deposits of oil shale in Colorado and has contributed importantly to development of techniques with which shale can be economically processed.

DOUBLING OF OIL RECOVERY from Diamond M, Sharon Ridge, and Kelly-Snyder reef pools of Scurry County, West Texas, is generally considered possible through unitization of leases and use of pressure maintenance by water and gas injection. Operators of 75 percent of producing oil wells in those pools have undertaken to inaugurate such a program. Area has about 1800 producing wells on 250 leases covering 80,000 acres, divided among 90 operators and 5000 royalty owners.

DEEPER PENETRATION with Dowell Glass Gun in casing perforating or open hole shooting

When you ask for Dowell Perfo-Jet Service, you receive the latest advancements in oil and gas well perforating! Now, Dowell has developed an expendable Glass Gun that allows the use of a larger explosive charge than do other types of guns. This extra detonating power gives you deeper, surer penetration of casing, cement and formation. Comparative "Standard drum tests" through 7" O. D. casing into cement and sand show the following results:

	Penetration	Hole Size
5" diameter jet perforating gun	8¼"	½"
Dowell expendable Glass Gun	12"	⅞"

Dowell's new Glass Gun is being used to good effect both in casing perforating and in open hole shooting. It consists of glass-enclosed, shaped charges in an expendable aluminum carrier . . . and can be tailor-made to fit a wide variety of shooting patterns and hole diameters. This self-destroying gun assures you of a junk free hole.

Call Dowell for your next perforating job. Ask for more detailed information on this new development.

DOWELL INCORPORATED
TULSA 3, OKLAHOMA
Subsidiary of The Dow Chemical Company

DOWELL

PERFO-JET SERVICE

Ask your nearest Dowell station for complete information on these Dowell services and products: Acidizing Service, Electric Pilot Services, Plastic Service, Chemical Scale Removal Service for heat exchange equipment, Jelflake, Paraffin Solvents, Magnesium Anodes for Corrosion Control, and Bulk Inhibited Hydrochloric Acid.

"First in Acidizing . . . since 1932"

Look to DOWELL

FOR OIL INDUSTRY CHEMICAL SERVICE

Editor's Page

OUR NATION SLEEPS

SOMETHING HAS HAPPENED to the people of the U. S. during the past two decades. Not long ago wasteful spending and debts were to be feared. They were liabilities and handicaps to be overcome. This is no longer true.

Although the national debt already stands at more than $250 billion, the American people today are shockingly indifferent about projected government expenditure of $71.6 billion for the fiscal year 1952, which runs from July 1, 1951 to June 30, 1952. An almost completely complacent attitude exists even though the government proposes a $7.2 billion tax increase above the record $47.8 billion collected in the 1951 fiscal year which ended June 30.

It is true that war caused much of the huge national debt, but wasteful, unnecessary spending made it much greater. In the 21 fiscal years since 1931, government spending has exceeded government revenues in 18 years, although this nation was at war but five of these years.

We've got another war on our hands, and again cannot avoid the burden of a huge defense program. This makes it imperative for non-defense spending to be slashed to the very bone. Cuts should go far beyond the nominal reductions made so far by the Congress.

• • •

IN CONTRAST WITH the exhibited complacency, the present situation should arouse a nationwide public demand that unnecessary expenses be avoided through elimination or deferment of all non-essential government spending. Instead, the public is content to watch government bureaus, departments and agencies continue to grow, and the people themselves ask for government financial assistance for everything under the sun.

In all, the federal government has taken in close to $225 billion during the last five fiscal years. This is nearly one-fourth more than during the previous five years, when we were in World War II, and more than double the total government revenue for the first four decades of this century. Government spending has risen from $9.2 billion in 1940 to $40.1 billion in 1950, or 4½ times greater. Lowest postwar expenditure was for the 1948 fiscal year, when $33.8 billion was spent.

IT IS CAUSE FOR ALARM that the general public demonstrates a lack of interest in government expenditures. It emphasizes that no one has full conception of the magnitude of a billion dollars—let alone $71 billion or $250 billion.

A billion dollars is a lot of money. If you owned $1 billion at the beginning of the year 1 A. D. and began repaying it at the rate of $1000 per day you would be a long, long way from paying off the debt today. In all, at $1000 per day it would require 2740 years to repay $1 billion. The national debt of the U. S. is 250 times greater.

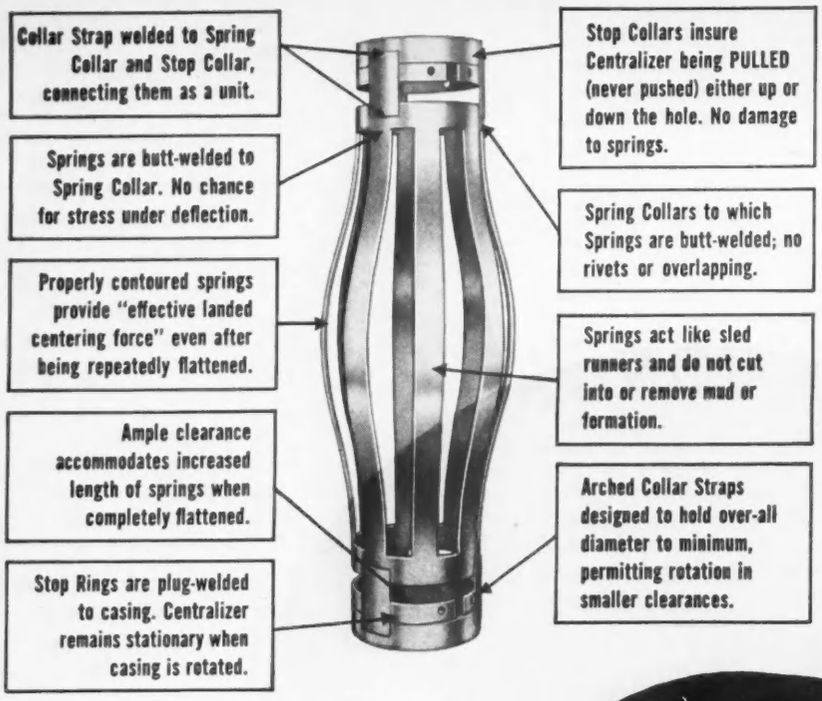
This nation is only 175 years old, but it is doubtful if the present national debt can be paid off during the next 175 years. To do this, the government would have to collect in taxes nearly $1½ billion per year ($4 million per day) more than it spends. That more than it spends factor is vitally important when expenditures in the peaceful fiscal years of 1949 and 1950 reached $40 billion or approximately $110 million daily. Dexter of radio fame would say, "Holy Cow."

• • •

THE NEED FOR STRICT ECONOMY in government expenditures is inescapable. Inflation is the most serious domestic problem faced by the U. S. today, and inflationary trends of the past few years have been due in large part to huge government spending. Circulation of the tremendously vast number of dollars by the government is bound to cause high prices, the cause of inflation being too much money in relation to goods available for purchase.

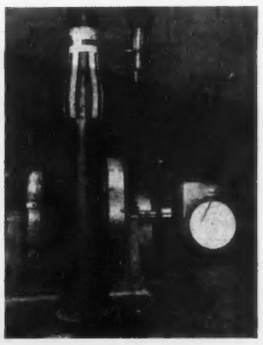
Yet the public is not interested enough to demand that squandering and wasteful government spending be stopped. They should be screaming to the housetops every time any government agency requests an unnecessary dollar.

Warren L. Baker

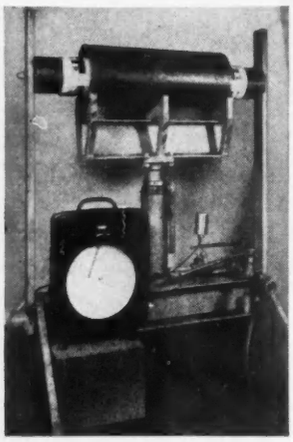

Collar Strap welded to Spring Collar and Stop Collar, connecting them as a unit.
Springs are butt-welded to Spring Collar. No chance for stress under deflection.
Properly contoured springs provide "effective landed centering force" even after being repeatedly flattened.
Ample clearance accommodates increased length of springs when completely flattened.
Stop Rings are plug-welded to casing. Centralizer remains stationary when casing is rotated.
Stop Collars insure Centralizer being PULLED (never pushed) either up or down the hole. No damage to springs.
Spring Collars to which Springs are butt-welded; no rivets or overlapping.
Springs act like sled runners and do not cut into or remove mud or formation.
Arched Collar Straps designed to hold over-all diameter to minimum, permitting rotation in smaller clearances.

EASY STARTING WITHOUT "SNUBBING"

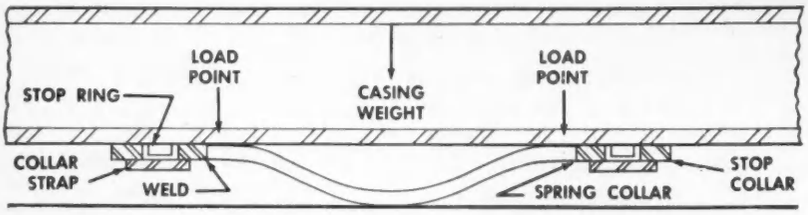
Testing to determine the maximum number of springs, of optimum bowed height and length, to insure easy starting, particularly of the first few joints when there is no accumulated weight. Minimum interval spacing of Baker Model "G" Casing Centralizers also was determined with this testing equipment.



With this testing device it is possible not only to simulate rugged downhole travel by repeatedly flattening the springs, but also to find the effective centering force of the centralizer in the open hole, after such treatment. The maximum centering force is easily determined from a performance curve showing centering force at various intervals of deflection.



Operators who know ALL the facts about the Baker Model "G" Casing Centralizer specify and run them exclusively. They know from experience that they are buying the greatest possible centering force for their casing, to be applied *exactly where they want it in the hole.* Isn't that what you too expect and really want from a casing centralizer?



Here is the ideal in spring design and mounting, found only in the Baker Model "G" Casing Centralizer. Note how the load point is imposed directly upon the casing; and how the properly "contoured" spring is free to move along the smooth surface of the casing as it deflects under compression. There is no chance for concentration of stress to cause a permanent set, or to result in breaking of the spring. Note that ample clearance exists between Stop Rings and Spring Collars to accommodate the increased length of the springs which results from their complete flattening.

Additional interesting facts and illustrations are contained in a new 16-page brochure which proves conclusively that no other spring-type centralizer even approaches the EFFECTIVE LANDED CENTERING FORCE afforded by the Baker Model "G" Casing Centralizer. Ask for your copy today from any Baker office or representative.

BAKER OIL TOOLS, INC.
Houston • LOS ANGELES • New York

The Changing Panorama

Price Control Evils Grip Industry Again

IN THE PETROLEUM industry the evils of price controls already have become evident again, as they did with serious results during and after World War II.

Pennsylvania grade crude producers, for example, declare that price controls now seriously handicap their operations. "We are apparently caught again between high costs and prices frozen at inadequate levels," declared C. E. Streeter, president of Pennsylvania Grade Crude Oil Association at its annual meeting in Mid-June. "Crude prices have not kept up with the mounting costs of labor, material, and drilling since the war," he stated. "The U. S. Bureau of Labor Statistics reports that the wholesale price of all commodities has increased 17 percent since the beginning of the Korean War. Farm prices are up 22 percent, textiles 35 percent, building materials 13 percent, and chemicals 26 percent for the same period. In contrast," Streeter continued, "our crude oil prices have only increased a little over 6 percent. This means only one thing: only the better acreage can be developed, and the marginal acreage will have to wait for a more favorable economic period."

While Pennsylvania crude has had the small increase mentioned, most crudes have not been increased at all since 1947, being at preKorea levels. Price controls already are proving their viciousness by restricting development not only in Pennsylvania but also in other areas. While marginal development becomes prohibitive, all other development becomes less attractive as costs and taxes increase. Several years of frozen crude prices would guarantee a future scarcity of crude.

Likewise, frozen product prices already are interfering with refinery operations by destroying freedom to vary yields of products from crude to fit market requirements. Heating oils, for example, are subject to relatively low price ceilings, and consequently, the future is quite likely to bring scarcities. Demand for heating oil is growing relatively faster than demand for gasoline, and the natural way to assure enough heating oil would be to step up prices a little if necessary, to get refiners to make more of it and relatively less gasoline. The problem would be simple under free movement of prices, but it probably will become complex and serious under government price fixing.

Price and wage controls are unsound economically because they restrict personal initiative, discourage production, and promote shortages, thereby feeding instead of choking inflation. Those controls are vicious politically because they restrict personal liberty and promote dictatorship.

We read about Russia or Stalin (they are one and the same now) having a master plan for the subjugation of the world. We are not doubting the existence of this plan, but if the Truman administration has any plan except to get re-elected, we can't imagine what it is.

Saving More Oil Is Industry Challenge

A BARREL OF OIL saved is a barrel of oil discovered, and scientists face the opportunity and the challenge of "finding" billions of barrels of oil through the magic of releasing the oil that now clings immovably within existing fields because the pressure has gone out of the reservoirs.

This is not an idle dream but the grand vision of reservoir engineers and others familiar with the problems of recovering oil from the reservoirs in which it is found.

The great possibilities of "finding" vast amounts of oil by increasing the percentage of recovery were called forcefully to the attention of the world by Lieut. Gen. Ernest O. Thompson, veteran member of the Texas Railroad Commission, speaking at the World Petroleum Congress at The Hague, Netherlands.

"The challenge to the oil scientists," declared Thompson, "is to find ways to get more oil out of the fields we discover.

"Great strides are being made in bringing old fields back into new producing life by water flooding and gas injection. One field in Texas has been rejuvenated from production of 2 barrels per well per day up to 500 barrels per well per day.

"I feel that our research in old thought-to-be depleted fields is our greatest opportunity to assure greater production," Thompson continued. "We got only 20 to 30 percent of the oil in place in the fields that were operated under old-time open-flow methods. Thus there is twice as much oil waiting to be produced as has been produced in these fields. This means something in the nature of 100 billion barrels of oil hidden in oil fields awaiting the researchers' magic touch to be released from the sands and rocks.

"It is truly a prize worth working on," Thompson declared. "It is hidden oil, but we know where it is hidden. All we need now is to find the way to cause Nature to give loose this oil now clinging to the rocks by reason of the pressure having gone out of the reservoir. Repressuring by gas and water-flooding are two methods being successfully used today. Research will find other and better methods to get this oil out for man's use."

Pugnacious Pacifism

IN READING the testimony of witnesses before the Senate Committee in connection with the MacArthur matter, it is striking how very pacific the Democratic members of the committee have been. One would think that they would shake their hands with horror or terror at the very thought of this country being engaged in war with another country. It almost makes one wonder if President Woodrow Wilson, President Franklin D. Roosevelt and President Harry Truman, the three gentlemen who were running the country when we got into our last three wars, were not Republicans.

Report from the Observatory

LOWER PRODUCING RATES AHEAD

By RAY L. DUDLEY, Publisher, and WARREN L. BAKER, Editor

OIL'S ECONOMIC POSITION became precarious the past month, as the industry maintained record operating levels despite several signs indicating caution would be a wiser course.

Stocks of both crude and products continued to accumulate at a rapid rate, although volumes in storage already were considerably above year-ago levels and therefore abundant despite unusually high consumption. With production scheduled to remain at peak rates in July, further enlargement of inventories will occur during the next month and bring the industry dangerously close to excessive stocks.

The outlook is further complicated by the possibility of a cease-fire agreement in Korea, which would have a pronounced effect on oil demand.

On the other hand, there was the question of whether nationalization of the Iranian petroleum industry would remove that oil, at least, temporarily, from international markets and throw a heavy supply burden on other countries. This, too, was an uncertainty, as Iran is confronted with the necessity of working out some plan of marketing its oil to avoid financial collapse.

In all, the industry seems to have been gambling that high stocks were to be needed because of the war, high industrial and civilian consumption, and even that Iranian oil would be lost. It may have lost this gamble.

• • •

LOWER PRODUCING RATES seem probable for the remainder of the year in view of prospective high inventory levels by the end of July.

During the four weeks ended June 16, U. S. crude oil stocks grew by 4 million barrels, attaining a level of 248½ million barrels, 9 million greater than a year ago, although they had exceeded 1950 volumes by only 1 million barrels a month ago. This increase in crude stocks took place despite record refinery operations which boosted refined product inventories sharply.

Seasonal drafts on U. S. gasoline stocks have been held to below normal quantities by peak output in recent weeks. The 128½ million barrels in storage in mid-June was 12 million barrels greater than in 1950, in contrast with being only 9 million barrels larger one month ago. Distillate fuel stocks, rising 408,000 barrels per day, climbed to 60¼ million barrels by June 16, nearly 13 million barrels more than a year previous as compared with being only 9 million barrels above year ago levels in mid-May.

Evidence of the precarious position into which the industry has worked itself by high operating levels was shown by the continuation and spread of retail gasoline wars in some marketing areas. General reductions ranging from 1 cent to 2 cents per gallon have taken place in gasoline tank wagon prices all along the East Coast from Maine to Florida. Spotted retail price cutting also was occurring in sections of Oklahoma, North Dakota, Texas, Louisiana, and Ohio. The occurrence of a weak gasoline market during the heavy consuming season for this product is a dangerous sign.

• • •

A CEASE-FIRE AGREEMENT in Korea would necessitate raising of the prospective cutback in producing rates to substantial proportions. Various sources estimate military demand at 375,000 to 400,000 barrels per day. In addition, a slowing down of defense preparations and of business in general likely would follow cessation of Korean hostilities, and have a further downward influence on oil consumption.

Demand for California oil would be especially affected, particularly for residual fuel oil. The latter might become a drug on the market, in contrast with its present strong position.

• • •

THE IRANIAN SITUATION is the $128 question. If nationalization results in the temporary removal of this oil from world markets, the loss would more than offset any reduced military demand. Willingness of the U. S. industry to build up stocks to present high levels has been based in part on this possibility.

However, there is no assurance that Iran's 700,000 barrels per day will not continue to enter world markets. Loss of revenue from oil would be disastrous financially and politically to the country, so Iran can be expected to make every effort to keep its industry operating. If an agreement cannot be reached with Anglo-Iranian Oil Company, Iran probably will attempt to hire U. S. technicians to run the big refinery at Abadan.

piping maintenance *costs more* now!

You spend less for it by using Dependable Quality

CRANE VALVES

. . . That's why more Crane Valves are used than any other make

Crane 150-Pound Steel Gate Valve

Steel valves that stay on the job

You can practically forget valve maintenance worries with Crane Cast Steel Wedge Gates. They're unusually rugged . . . amply reinforced at all stress points. Disc is precision-guided to reduce seating surface wear. Straight-through ports give smooth flow, with minimum turbulence and erosion.

Stuffing box depth and design assure tight stem seal . . . long packing life. Valves available in trim materials for steam, water, gas, oil, and oil vapor services.

Ask your Crane Representative about the better quality and greater dependability of Crane valves—your assurance of on-the-job performance that spells lower final cost.

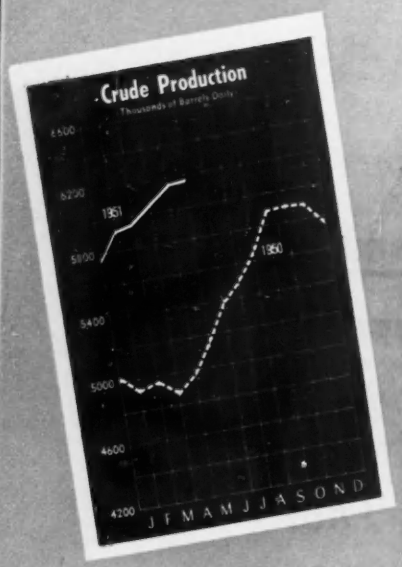
CRANE

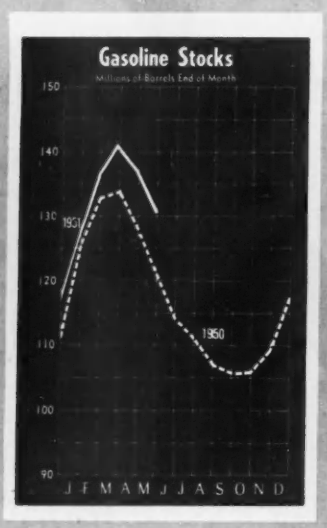
CRANE CO., *General Offices:*
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

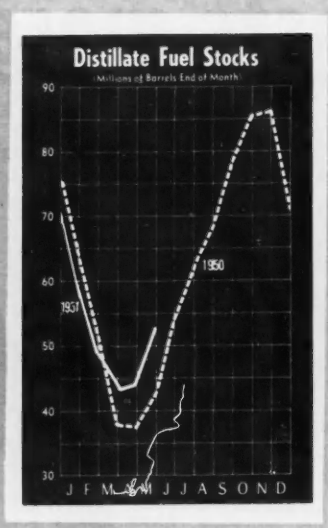
VALVES • FITTINGS • PIPE • PLUMBING • HEATING

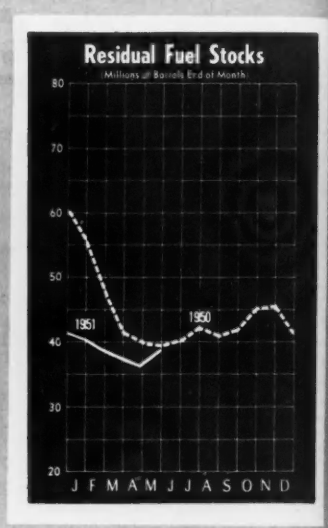
Petroleum

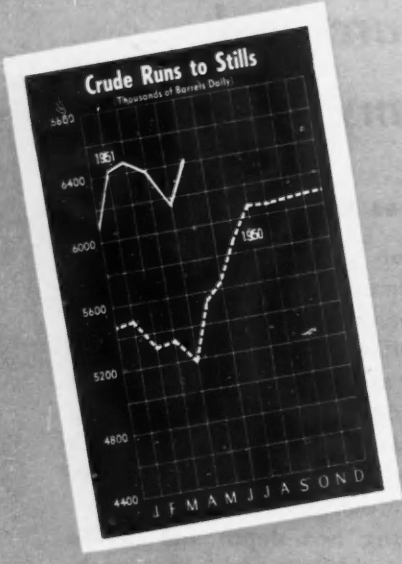
By CECIL W. SMITH,

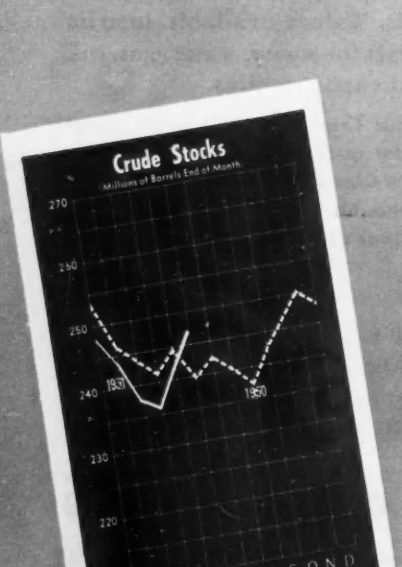












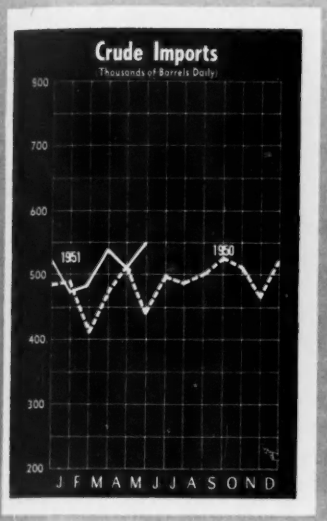
U. S. Crude Production by States

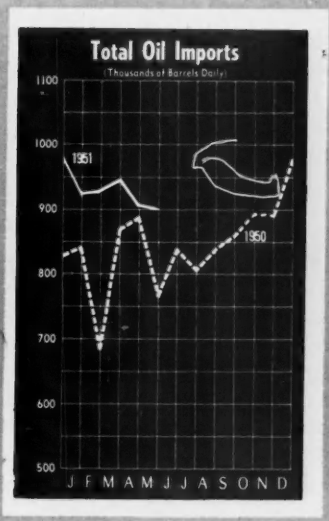
(THOUSANDS OF BARRELS)

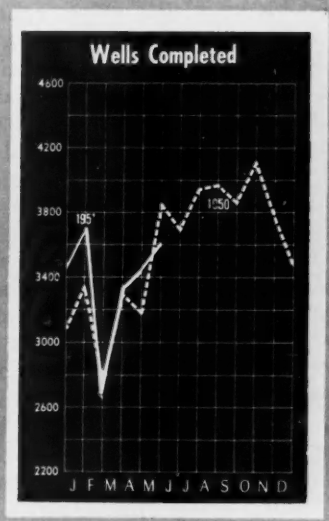
STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION First Five Months		
	May, 1951	April, 1951	May, 1950	% Diff. May, '51-'50	1951	1950	% Diff. '51-'50
Alabama	2.9	2.8	1.7	+ 70.6	410	240	+ 70.8
Arkansas	82.3	81.4	85.6	— 3.9	12,389	12,950	— 4.3
California	965.1	966.1	871.6	+ 10.7	145,375	130,419	+ 11.5
Colorado	73.9	78.6	60.4	+ 22.4	11,415	9,140	+ 24.9
Florida	1.6	1.6	0.9	+ 77.8	240	151	+ 58.9
Illinois	168.8	160.5	170.6	— 1.1	24,500	25,739	— 4.8
Indiana	28.8	27.9	27.6	+ 4.3	3,991	3,997	— 0.2
Kansas	312.7	314.3	291.7	+ 7.2	46,909	42,729	+ 9.8
Kentucky	27.1	27.3	29.5	— 8.1	4,185	3,893	+ 7.5
Louisiana	645.0	642.8	539.0	+ 19.7	95,806	82,072	+ 16.7
North Louisiana	130.5	129.2	120.4	+ 8.4	18,688	18,643	+ 0.2
South Louisiana	514.5	513.6	418.6	+ 22.9	77,118	63,429	+ 21.6
Michigan	40.5	40.4	45.6	— 11.2	6,025	6,755	— 10.8
Mississippi	102.5	103.1	103.0	— 0.5	15,557	15,033	+ 3.5
Missouri	0.1	0.1	0.1	.....	11	12	— 8.3
Montana	23.9	23.8	22.4	+ 6.7	3,606	3,263	+ 10.5
Nebraska	7.7	9.6	2.7	+185.2	1,296	330	+292.7
New Mexico	141.4	142.3	130.0	+ 8.8	21,135	19,377	+ 9.1
New York	14.1	13.9	12.0	+ 17.5	1,888	1,724	+ 9.5
Ohio	9.4	8.4	9.4	.....	1,306	1,378	— 5.2
Oklahoma	504.8	499.2	426.9	+ 18.2	75,737	61,987	+ 22.2
Pennsylvania	29.7	29.6	33.1	— 10.1	4,686	4,720	— 0.7
Tennessee	0.1	0.1	0.1	.....	8	10	— 20.0
Texas	2,789.8	2,767.8	2,113.1	+ 32.0	405,518	300,201	+ 35.1
Dist. 1—South Central	33.9	33.7	27.5	+ 23.3	4,984	3,986	+ 25.0
Dist. 2—Middle Gulf	168.1	165.9	124.5	+ 35.0	24,305	17,791	+ 36.6
Dist. 3—Upper Gulf	504.2	503.6	397.0	+ 27.0	73,739	55,922	+ 31.9
Dist. 4—Lower Gulf-S.W.	260.8	258.0	197.9	+ 31.8	37,731	28,243	+ 33.6
Dist. 5—East Central	52.7	51.8	31.9	+ 65.2	7,449	4,549	+ 63.8
Dist. 6—Northeast	390.8	394.5	351.0	+ 11.3	58,097	49,354	+ 17.7
Dist. 7-B—North Central	86.0	83.7	67.1	+ 28.2	12,208	9,585	+ 27.4
Dist. 7-C—West Central	103.3	99.4	58.6	+ 76.3	14,112	7,801	+ 80.9
Dist. 8—West	947.9	937.0	643.2	+ 47.4	135,606	88,605	+ 53.1
Dist. 9—North	153.5	150.6	139.0	+ 10.4	22,849	20,325	+ 12.4
Dist. 10—Panhapdle	88.6	89.6	91.4	— 3.1	13,506	13,644	— 1.0
Utah	3.4	3.4	3.3	+ 3.0	521	471	+ 10.6
Virginia	0.1	0.1	0.1	.....	9	10	— 10.0
West Virginia	7.5	7.5	7.9	— 5.1	1,129	1,185	— 4.7
Wyoming	185.9	186.0	155.0	+ 19.9	28,527	23,583	+ 21.0
Total United States	6,169.1	6,138.7	5,143.3	+ 19.9	912,179	751,369	+ 21.4

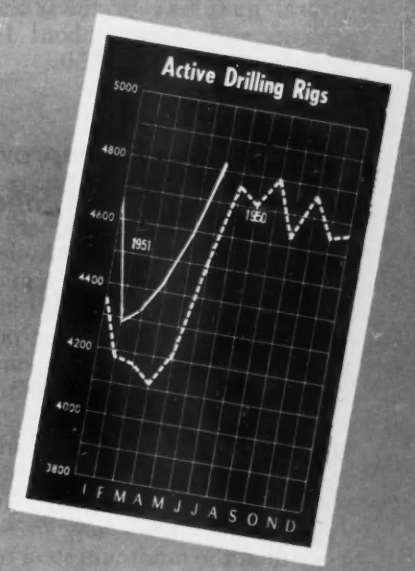
Trends in U. S.

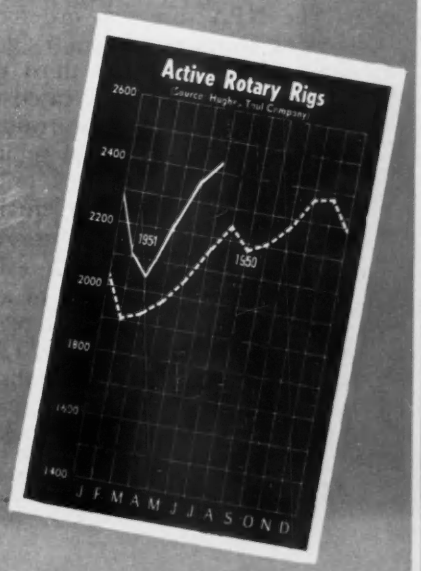
WORLD OIL Staff











Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1949:											
May	4,972	5,195	273,912	2,585	121,602	813	57,442	1,138	63,576	409	572
June	4,903	5,162	274,691	2,597	114,041	771	64,730	1,041	64,628	400	598
July	4,704	5,173	267,586	2,613	111,217	835	71,553	1,040	66,084	428	624
August	4,780	5,241	260,585	2,593	104,879	902	76,037	1,078	66,843	413	614
September	4,940	5,427	251,689	2,617	101,799	1,002	83,213	1,110	67,117	374	623
October	4,997	5,373	250,932	2,643	103,287	1,001	90,643	1,141	68,673	492	785
November	5,210	5,293	256,010	2,594	104,707	962	88,212	1,180	65,112	435	703
December	5,024	5,475	253,356	2,633	111,521	1,032	75,207	1,203	60,193	485	828
1950:											
January	4,922	5,483	246,610	2,575	125,298	1,048	63,932	1,209	55,808	487	841
February	4,967	5,316	243,750	2,552	132,796	1,026	52,206	1,172	47,828	411	684
March	4,878	5,336	241,098	2,539	133,766	938	37,777	1,154	41,860	471	869
April	4,968	5,193	244,605	2,508	128,057	977	37,530	1,048	39,979	511	888
May	5,143	5,535	239,877	2,647	121,035	997	42,739	1,063	39,482	439	766
June	5,378	5,655	242,287	2,748	114,074	1,037	53,679	1,069	40,124	498	838
July	5,484	5,882	240,270	2,835	111,055	1,040	62,555	1,140	42,165	486	806
August	5,665	6,067	237,393	2,932	107,067	1,089	68,426	1,148	40,979	501	839
September	5,888	6,059	242,311	2,849	105,748	1,180	78,270	1,178	41,966	525	859
October	5,900	6,077	246,424	2,875	105,764	1,217	85,643	1,250	45,004	510	896
November	5,891	6,085	250,016	2,859	109,005	1,218	86,113	1,240	45,048	466	891
December	5,758	6,092	247,814	2,872	117,220	1,307	70,875	1,280	41,184	521	979
1951:											
January	5,907	6,450	243,107	2,962	128,479	1,427	58,424	1,368	40,317	499	977
February	5,930	6,562	235,247	2,906	137,243	1,419	47,587	1,382	39,409	468	937
March	6,052	6,469	233,824	2,908	141,456	1,327	42,978	1,348	37,516	483	861
April	6,127	6,183	243,180	2,821	139,188	1,171	44,736	1,230	36,910	511	871
May	6,169	6,435	247,662	2,982	130,412	1,191	53,714	1,288	38,440	550	900
May, 1951 Change:											
In Month	+42	+252	+4,482	+161	−8,776	+20	+8,978	+58	+1,530	+39	+29
In Year	+1,026	+900	+7,785	+335	+9,377	+194	+10,975	+225	−1,042	+111	+134
Week Ended:											
6- 9-51	6,168	6,445	246,660	3,032	129,353	1,240	57,372	1,274	38,839	528	808
6-10-50	5,305	5,524	239,464	2,718	119,249	994	45,230	1,044	39,192	....	....

Monthly News Analysis

9.5 Percent Demand Hike Seen by Bureau of Mines

Total demand for all oils will be 9.5 percent greater in 1951 than in 1950, the Bureau of Mines estimated in its revised forecast for 1951. This will include gains of 14.1 percent for the first quarter, 11.0 percent for the second, 7.6 percent for the third, and 6.0 percent for the fourth. Diminishing relative gains reflect sharply rising demand in the latter half of 1950.

The expected 9.5 percent annual gain in demand for 1951 includes increases of 11 percent for motor fuel, 6 percent for residual fuel oil, 14 percent for distillate fuel oil, 11 percent for kerosine, and 5 percent for all other products. To meet demand, the Bureau estimates need for increases of supply as follows: domestic crude production 11.6 percent above 1950, natural gasoline production up 12 percent, and imports about 11 percent greater than in 1950.

Chances May Be Improved For Getting Needed Steel

Inauguration of the Controlled Materials Plan on July 1 plus a mid-June directive of the National Production Authority requiring larger percentages of steel alloy production to be set aside to fill defense rated orders may offer stronger assurance that oil producers will receive established quotas of tubular goods for third and fourth quarter operations. At best, though, both moves may provide no more than the minimum steel requirements to fill the Petroleum Administration for Defense's planned completion of 43,400 wells in 1951.

The NPA directive ordered mills making seamless oil country goods to set aside their entire third quarter production for defense rated orders; and makers of seamless pressure tubing, seamless mechanical tubing and tube rounds are required to reserve 85 percent of their production for such orders.

With this action, NPA estimated third quarter production of all alloy steel will total 1,800,000 tons, an increase over actual output of 1,200,000 tons in the first three months of the year. Regardless of the anicipated increased steel supply, no additional allocation of steel has been planned for the petroleum industry. The industry's total for use during July, August and September is 963,000 tons for oil and gas operations aside from the producing branch through the Defense Production Administration's Controlled Materials Plan. PAD has been allocated 450,000 tons of tubular goods for third quarter distribution to producers and 180,000 tons of steel for rationing to manufacturers of oil field equipment.

While these moves to protect steel supplies for essential users, including petroleum, may be of substantial benefit in meeting the minimum drilling program established, some cutback in the present high rate of completions may be in prospect. Regarding such a possibility, George J. Hanks, president of South Penn Oil Company, told the annual meeting of the Pennsylvania Grade Crude Oil Association last month: "At the rate producers generally are drilling and developing, we estimate that the steel available and to be available during the next (third) quarter will be entirely exhausted, making it essential that the development rate from October 1 be governed entirely by the amount of steel our industry may receive."

J. Ed Warren, president of the Independent Petroleum Association of America, warned that with the full impact of the preparedness program yet to be felt, the increased trend of oil requirements must be expected to continue. Meeting such demands will require "greatly increased" steel supplies, Warren noted. The "unrealistic" government policies, he continued, established allocations of "less than what is considered to be the minimum steel requirements for the oil industry."

The domestic demand for pipe above allocations has resulted in imports of pipe and steel from Germany, Italy and France at landed prices about twice those set for exports of oil country goods from the U. S., according to Russell B. Brown, general counsel of the IPAA. These imports are placed at the rate of 25,000 tons a month.

So far this year, U. S. operators have drilled about 5 percent more wells than in the corresponding period last year, and the amount of footage drilled has been about 7 percent greater. The fact that it has been possible to do this amount of drilling in spite of the steel shortage is explained by the using up of warehouse inventories, purchases of imported foreign-made pipe at high prices, and increased use of second-hand pipe. As inventories are now largely used up in many instances, increased difficulty in maintaining drilling is indicated.

Oil Discovery May Change Land-Purchase Practices

The recent oil strike in North Dakota may bring about a change in land acquisition policies of the U. S. Corps of Engineers.

Heretofore the corps of engineers has acquired mineral rights as well as surface rights to lands involved in public works. Following Amerada Petroleum Corporation's oil strike at Tioga in the Williston Basin, landowners negotiating with the federal government for lands to be included in the Garrison dam reservoir are demanding a change in policy enabling them to retain their mineral rights. The engineers have acquired approximately 400,000 acres but need an additional 100,000 acres to complete the block for the dam.

The impact of oil has already hit land-owning North Dakotans hard. Millions of acres are under lease and additional blocks are being assembled in anticipation of one of the heaviest drilling campaigns ever undertaken by majors and independents within the past decade.

There is no federal law which requires the government to acquire mineral rights, but representatives of the corps of engineers believe that unless appropriate legislation is enacted, landowners who have parted with their mineral rights have little chance of reclaiming those rights from the government.

Landowners in the vicinity of the Garrison Dam reservoir have formed an organization to help facilitate leasing of their lands for oil and gas development. Some of their estimated 80,000 acres of land lie within the reservoir area and although it is too early to predict whether production will be developed within the area, it is certain the landowners will challenge the government on the mineral rights issue.

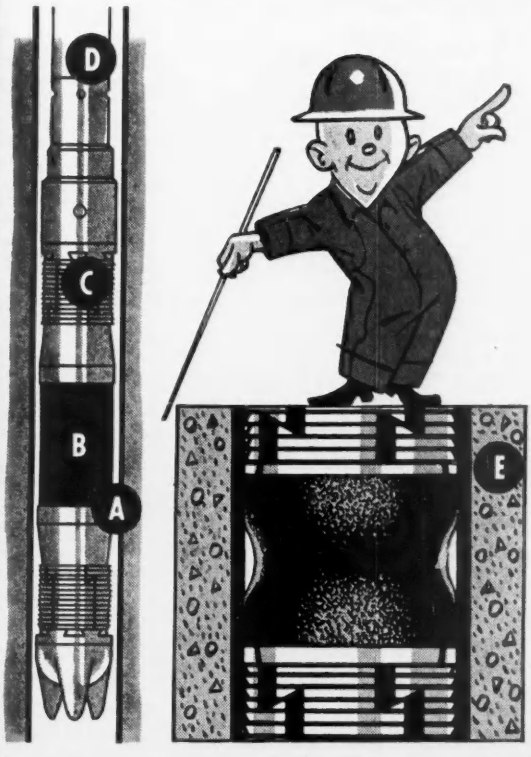
Under sponsorship of Senators

You can read all about 'em—if you want to

now—let's just look at a few reasons why operators like

LANE WELLS

DRILLABLE BRIDGING PLUGS



A Notice the greater clearance — this means faster running in fluid.

B Longer sealing element — for leakproof pack-off.

C These BIG interlocking slips hold fast on any casing without casing damage.

D This removable ram-adapter cuts down knock-out time. With either rotary or cable tools, you can drill out or knock down a Lane-Wells Bridging Plug in 4 to 6 hours.

E Positive pack-off right where you want it, as long as you want it — resists pressure from above or below. Under normal conditions, Lane-Wells Drillable Bridging Plugs have successfully withstood differential pressures as high as 10,000 p.s.i.

Tomorrow's Tools—Today!

Ask Your Lane-Wells Man!

Los Angeles • Houston • Oklahoma City • Lane-Wells Canadian Co. in Canada • Petro-Tech Service Co. in Venezuela
General Offices, Export Office and Plant • 5610 So. Soto St. • Los Angeles 58, California

Young and Langer (R., N. D.), a bill (S. 1413) has been introduced in the U. S. Senate to permit private owners to retain oil, gas, and other mineral rights in lands condemned by the U. S. for waterway improvement purposes. An identical bill (H. R. 3955) was introduced in the House by Representative Burdick (R., N. D.).

Summer Motorists to Use Billion Gallons of Gasoline

In vacation travel in June, July, and August this year, American motorists are expected to travel 15 billion miles and use 1 billion gallons of gasoline, equivalent to 23,809,524 barrels, or 258,800 barrels daily average.

To provide this volume of gasoline from crude at the current average refinery yield of about 41 percent will require 631,000 barrels of crude per day. That is more than the capacity of the world's greatest refinery at Abadan in Iran. It is more than the production of any foreign country except Venezuela, Russia, Iran, or Saudi Arabia. This amount of crude production needed to make the gasoline to be consumed for U. S. vacation travel this summer will be equal to the crude output during the period in 19 states and part of another state. The 631,000 barrels per day of crude needed to yield the 258,800 barrels per day of gasoline for vacation travel is more than the aggregate production of New York, Pennsylvania, Virginia, West Virginia, Ohio, Michigan, Illinois, Indiana, Kentucky, Tennessee, Missouri, Nebraska, Florida, Alabama, Mississippi, Arkansas, Colorado, Montana, and Utah.

This summer need for gasoline for vacation travel will require more than one-tenth of the current U. S. production of gasoline and more than a tenth of current U. S. crude production.

The Americans who use this gasoline will not be wasting it nor jeopardizing the national defense. They will be "seeing America first" and developing greater love for their country and greater solidarity and unity, besides gaining recreation that will make them more efficient and happy in their work after the vacation period.

The summer use of gasoline for vacation travel will be 54 percent of this use for the whole year, according to the American Petroleum Institute, citing a survey by a national magazine. Of the year's trips, 23.3 percent are in the fall, 9.7 percent in winter, and 13 percent in spring. The average trip lasts 11 days and covers 1000 miles. There are now more than 40 million passenger cars in use and 10 million trucks and busses, served by 200,000 service stations.

Treasury Report Argues Against Treasury Views

Having advocated reduction of the percentage depletion allowance, the U. S. Treasury Department sought to increase income taxes paid by oil companies and thereby to reduce their net profits.

Yet the same department recently released information showing that in the boom year 1948 over one-third of the companies actively engaged in oil and gas production failed to show any profit. Actually, they suffered losses, and the depletion allowance was for them only an academic matter, because they had no net income to apply the allowance against. Many other companies doubtless were only on break-even or barely profitable basis, indicating that probably less than one half of the oil and gas operators showed worth-while profits.

Even those that showed profit had to earn $3 in order to keep each $2, for out of each $3 of net income, before taxes, they paid $1 in federal income taxes, in spite of such benefit as could be taken from the depletion allowance.

The Treasury Department's preliminary summary of income tax returns for 1948 showed that of 3987 oil and gas producing corporations filing returns, 1424, or 36 percent, had no net income and suffered total deficit of $40,718,000. The other 2563 oil and gas corporations had total net income of $460,206,000, of which $157,417,000 went for federal income taxes.

Testimony in Phillips Gas Hearing Received by FPC

In deciding if Phillips Petroleum Company is subject to regulation by it under the Natural Gas Act of 1938, the Federal Power Commission will be guided by 5843 pages of testimony taken at a 39-day hearing in Bartlesville, Okla., between April 3 and May 25. The testimony went direct to FPC in Washington, as the customary intermediate report by the trial examiner was omitted. Both sides agreed to file briefs with FPC by June 22 and reply briefs by July 5.

Oil and gas producers are greatly concerned with FPC's contemplated assertion of regulatory powers over production and wellhead sales of gas, and are hoping the commission will decide against undertaking such regulation. On the other hand, municipal and state politicians from consuming areas, Truman administration men, and various other interests have urged FPC to attempt regulation all the way to the wells, and FPC itself has in the past shown ambitions to wield the powers in question.

It is significant that FPC held the recent lengthy hearing after reversing an earlier decision to postpone the hearing indefinitely because Phillips officials were busy with national defense projects. Presumably, the commission changed its mind and decided to go ahead with the hearing after being subjected to pressure calling for immediate FPC action.

FPC clearly would be powerfully supported in a decision to try to regulate production of gas and oil. It probably would be backed by both the President and the U. S. Supreme Court, though Congress in the Natural Gas Act of 1938 specifically exempted independent producers from FPC regulation. President Truman last year vetoed the Harris-Kerr Bill, which spelled out exemption of independent producers from FPC control, and several Supreme Court decisions in gas cases have indicated that the court approves strong powers for FPC. Especially significant was the Supreme Court decision of January 9, 1950, reversing a lower court decision in February, 1949, that East Ohio Gas Company was not a "natural gas company" under the Natural Gas Act. Although numerous state agencies and authorities joined in a petition for a rehearing, the Supreme Court denied the appeal.

Apparently, the only way in which FPC can be effectively restrained from regulating production of gas and oil is through specific legislation such as was blocked last year by the Truman veto.

Texas Commission Denied Authority in Col-Tex Case

Powers of the Texas Railroad Commission in administering oil proration do not include authority to require a pipe line company to purchase crude ratably from all fields on its line, the Texas Supreme Court held June 6. The decision upheld Col-Tex Refining Company in opposing an order of the commission requiring the company to buy ratably from all fields on its 65-mile pipe line in four West Texas counties serving the company's refinery at Colorado City.

The commission contended that a purchaser must buy oil ratably among fields as well as ratably from wells within each field. A district judge at

Drop Forgings?

Now you're talking our language!

We're old hands at the business of making drop forgings; been doing it a long, long time. And during that time we've developed a complete, integrated service that in many ways simplifies things for the customer.

Here at Bethlehem you'll find both die-making and steel-making facilities; a battery of steam and board hammers, mechanical presses, and upsetters; and a full complement of modern heat-treating equipment. But that isn't all. Bethlehem offers, in addition, the services of picked metallurgists, whose job is to check on quality right down the line.

Designs? We can handle an endless variety. Weights? Approximately 1½ to 250 lb.

Over the years, Bethlehem has turned out many millions of closed-die forgings for the automotive, petroleum, aviation, electrical, mining, and other industries. This is a broad type of experience that is helpful to the user of drop forgings.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Austin granted an injunction against enforcement of the order. The trial judge was reversed by the Court of Civil Appeals but was then upheld by the Texas Supreme Court.

In view of the final decision, it appeared that pipe line proration might arise in Texas. Efforts were made in the Texas Legislature to enact a law that would definitely authorize the Railroad Commission to require pipe lines to buy oil ratably among fields as well as among wells within each field. But there was very little time to consider the matter before the Legislature adjourned, and action was not taken on it. One of the objections raised was that the proposed law might be undesirable because it would allow the commission also to require ratable taking by gas pipe lines of the natural gas production of each field along the line.

Justice Department Drops Mother Hubbard Litigation

The U. S. Department of Justice on June 6 dismissed the "Mother Hubbard" case, filed September 30, 1940, against 367 defendants representing virtually the whole industry. The action was taken in order to prevent delay in its antitrust suit against seven West Coast major oil companies. These companies had before the U. S. Supreme Court a plea for a stay in their case pending disposal of the old suit. Dismissal of the old case made moot the appeal in the new case and left the Justice Department free to go ahead with the latter.

In discussing dismissal of the big suit, Justice spokesmen warned that there would be more of the smaller or segment suits, such as those already brought separately against Sun Oil Company, Richfield Oil Corporation and the seven West Coast companies. Justice Department found that the "Mother Hubbard" case was so big and covered so many questions and defendants that it was unwieldy and virtually impossible to handle.

H. Graham, Morison, assistant attorney general in charge of the antitrust division, made clear before a congressional committee June 12 that the oil industry will continue to be a major target of the division; that the division is not getting "soft" with reference to the oil industry. Since the Sherman Act was passed, stated Morison, the division's major battles have been against the oil industry. He made these comments in testifying regarding proposed extension of the Interstate Oil Compact Commission, though neither approving nor disapproving the compact.

Industry Advances Studies For Production Expansion

Good progress is being made in important studies by industry committees on costs in money and steel for commercial synthetic fuel plants and for a million-barrel-per-day expansion of the existing U. S. oil industry. Sponsored by the National Petroleum Council at the request of Oscar Chapman, Secretary of the Interior, the studies are designed to help shape defense undertakings with respect to oil.

The studies on costs of production of synthetic liquid fuels are being made by a committee headed by W. S. S. Rodgers of The Texas Company, which hopes to complete a report on coal hydrogenation and shale oil processing in September. Studies on coal gasification and fuel synthesis processes are being deferred because of the problems involved. Oil industry experts heretofore have cast doubt on the economic feasibility of synthetic oil production at present, but the U. S. Bureau of Mines has claimed that synthetics are now competitive or nearly so, and in view of defense considerations, Secretary Chapman is promoting this current comprehensive study of the subject.

NPC's "million barrel" committee has divided its studies into four parts to determine respective costs of four different undertakings that apparently are assumed as practical for achieving expansion of a million barrels per day in petroleum products availability.

Significant Conservation Steps Made in Oklahoma

Oklahoma oil men recently observed two significant events marking important steps in the conservation of the nation's oil and gas resources.

One was the dedication of Shell Oil Company's Elk City gas processing and recycling plant in Beckham County, and the other, Phillips Petroleum Company's inauguration of large-scale water-flooding of 22,000 acres in the Burbank field of Osage County comprising the largest single water-flood unit in the world.

These two projects, each an individual effort, but sponsored and financed by 26 oil companies (nine in the Elk City plant and 17 in the Burbank flood project), assure an additional 200 million barrels of oil will be produced.

This assured production is equivalent to the discovery of two major oil fields—a factor of great significance in view of continued demands for petroleum products and dwindling reserves. It is made possible by the spirit of understanding and cooperation which has marked the oil industry's activities during the past 20 years.

Construction of the gas processing and recycling plant in the Elk City pool of western Oklahoma constitutes the successful culmination of a daring but farsighted policy initiated and carried to fruition by Shell. Keenly conscious of the need to conserve and produce as much oil as possible from the Elk City pool, considered the most important discovery in the Mid-Continent area during the past ten years, Shell management undertook to unitize nearly 5000 producing acres and to invest about $7 million in a modern plant even before reserves had fully justified such an expenditure.

Elk City produces mostly gas condensate, and Shell engineers realized that unless pressure maintenance was initiated in the early life of the field, millions of barrels of valuable liquid hydrocarbons would be lost. The other eight major operators in the field elected to risk the money required to construct the present modern gas processing and recycling plant, and hundreds of royalty owners agreed to pool their interests in the unit.

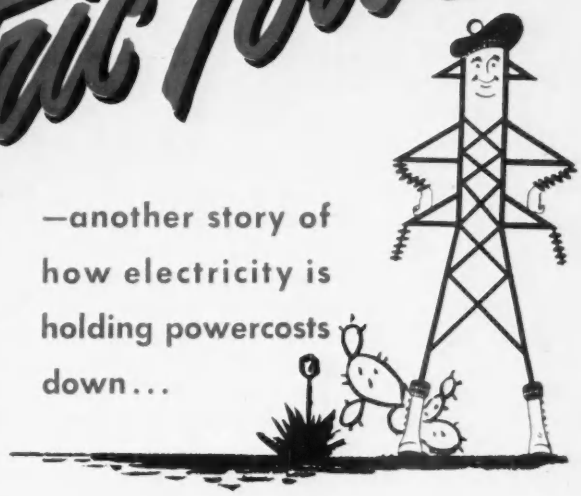
It is estimated that more than 25 million additional barrels of liquid hydrocarbons will be produced from Elk City, and this figure may be substantially increased since the limits of the pool, which now covers about 9000 acres, have not yet been defined.

Across the state in northeastern Oklahoma the valve which turned water into the first 1000 acres to be flooded in Osage County's North Burbank pool spells not only additional oil for the industry and the nation, but a reconaissance of the oil business for the Osage Indians, who were once the richest Indian tribe in the world.

Phillips Petroleum Company and its 16 partners in the 22,000 acres in the Burbank unit, estimate that more than 140 million barrels of additional oil will be produced from the field.

Of still greater significance, that flooding at Burbank will result in the flooding of many depleted oil pools in Osage County which, since the turn of the century, has produced in excess of 600 million barrels of oil. Engineers believe that almost as much oil will be produced during the next 30 years as a result of such opertions. Renewed interest in abandoned oil fields in the Osage has been shown by many independent operators who have applied for leases on such fields, and who plan to reactivate them by flooding.

West Texas Pumps with Electric Power



—another story of how electricity is holding powercosts down . . .

Regardless of the locale, climate or conditions, you'll find ELECTRIC POWER efficient, dependable and at rock bottom in cost. The scene at the left is in the famed Permian Basin of West Texas, which is known for its cactus, mesquite and sandstorms as well as its oil. Here ELECTRIC POWER is on the job in every operation of the Petroleum Industry. Call the Power Engineer of your Utility Electric Power Company and let him show you how to cut down your power costs.

Petroleum Electric Power ASSOCIATION

ORGANIZED
IN THE INTEREST OF GREATER SERVICE
TO THE PETROLEUM INDUSTRY

★

CALL YOUR NEAREST ELECTRIC SERVICE COMPANY FOR MORE FACTS—OR ADDRESS YOUR REQUEST TO P. O. BOX 2771, DALLAS, TEXAS

•

Electric Power Does More—Costs Less

Completions

2.3 Percent Above 1950

WELL completions in the U. S. totaled 3673 during May to top the previous month's drilling efforts by 208 wells and to push the year's five-month total to 17,029, which was 382 wells or 2.3 percent greater than those drilled a year before. The lead that the current drilling campaign has over that of 1950 was narrowed considerably during May, and while wells being completed were on the increase they did not keep step with those finaled in May of last year.

At the end of April, the number of wells drilled in 1951 was 5 percent higher than that of a year ago, but when results in May failed to match last year's by several hundred wells, the advantage was dropped to less than one-half. However, active drilling rigs at the end of May were at their highest point since the close of 1948, and a further increase in the year's drilling should be in evidence when June's results are tabulated.

Although total wells drilled so far this year had an edge over record-breaking 1950, the number of producers lagged substantially. By the end of May, 589 fewer oil wells had been completed. Distillate producers were 76 less numerous, and the only producing wells on the increase were gassers with a gain of 142.

Actually, the big increase in this year's drilling has been in the ranks of dry holes. In the first five months, 6194 dusters were drilled against 5334 in the comparable period of 1950. That was principally due to the increase in exploratory drilling where dry hole-per-producer ratios are always high. Over all, 860 more failures were drilled this year, but 494 were classed as exploratory. Thus, exploration accounted for more than one-half of the dry hole increase, while it accounted for only a little more than one-fifth of total drilling.

Well Completions in the United States During May, and First Five Months, 1951

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from the *"Producers Monthly."*)

State or District	MONTHLY COMPLETIONS, MAY, 1951									TOTAL COMPLETIONS				CUMULATIVE TOTALS January-May					Rigs in Operation (Drilling, Rigging-Up and Shut Down)		
	NEW WELLS								Total Drilled Deeper												
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New		May, 1951	April, 1951	May, 1950	Footage May, 1951	Wells 1951	Wells 1950	Percent Diff.	Footage 1951	Footage 1950	May 31, 1951	April 30, 1951	May 31, 1950
Alabama	4			2				6		6	7	5	26,296	27	15	+ 80.0	122,023	54,268	3	3	3
Arizona														2			3,820		2		4
Arkansas	20		2	11				33		33	32	37	95,699	148	155	— 4.5	518,938	501,979	31	24	24
California	146		3	43				192	9	201	201	157	799,070	968	754	+ 28.4	3,678,855	3,109,143	247	229	223
Colorado	8			8				16		16	22	3	73,551	79	18	+338.9	377,576	61,022	27	24	12
Florida											1	1		1	7	— 85.7	1,684	44,386	1		1
Georgia															2	—100.0		9,075			
Idaho														1	3	— 66.7	12,844	8,540			3
Illinois	74			148				222		222	138	251	564,758	760	900	— 15.6	1,866,401	1,843,591	222	195	249
Indiana	21			64				85	1	86	53	149	156,284	373	537	— 30.6	661,877	933,886	170	167	191
Kansas	171	1	48	180			3	403		403	296	408	1,363,153	1,579	1,488	+ 6.1	5,335,375	4,836,180	409	433	351
Kentucky	45		19	56				120		120	87	84	245,124	435	369	+ 17.9	863,100	686,982	107	93	108
Louisiana	70	11	7	76				164		164	162	206	1,079,472	819	969	— 15.5	5,355,435	6,047,877	210	223	217
North Louisiana	35	4	3	41				83		83	94	107	362,849	418	487	— 14.2	1,607,483	1,786,769	72	75	71
South Louisiana	35	7	4	35				81		81	68	99	716,623	401	482	— 16.8	3,747,952	4,261,108	138	148	146
Maryland			3					3		3	1		10,635	10	1	+900.0	37,002	3,612	21	16	2
Michigan	11		3	38				52		52	53	93	140,402	256	326	— 21.5	648,112	776,861	111	120	140
Mississippi	13	1	5	18				37	1	38	19	29	256,018	122	153	— 20.3	837,711	1,141,724	31	36	24
Missouri											3	3		3	20	— 85.0	658	13,668	6	5	7
Montana	20			10				30	1	31	19	26	68,819	83	83		182,890	232,780	43	41	29
Nebraska	5		1	7				13		13	15	7	65,066	58	28	+107.1	265,801	113,129	10	12	3
Nevada				1				1		1			5,117	2			15,431		2	2	1
New Mexico	22		12	11				45	2	47	75	43	211,928	264	242	+ 9.1	1,219,089	1,102,823	114	118	75
New York	27				20			47		47	45	50	67,567	206	266	— 22.6	291,646	374,840	57	70	83
North Dakota														1			5,609		2	2	
Ohio	19		20	25				64	3	67	63	83	128,740	328	362	— 9.4	660,504	784,494	156	119	131
Oklahoma	241		22	183	8	2	1	457	15	472	430	532	1,673,624	2,250	2,157	+ 4.3	8,061,555	7,419,463	604	590	527
Oregon																					1
Pennsylvania	55		12	4	54	4		129	2	131	131	133	224,416	554	608	— 8.9	975,358	1,111,517	241	214	251
South Dakota															1	—100.0		5,710			2
Tennessee												2			3	—100.0		3,993	5	6	9
Texas	816	17	59	485	4	2		1,383	30	1,413	1,520	1,479	6,118,414	7,158	6,691	+ 7.0	30,569,991	28,242,766	1,679	1,544	1,502
Dist. 1 S. Central	20	1	1	26				48	6	54	53	42	183,286	262	185	+ 41.6	728,545	516,724	40	38	30
Dist. 2 Middle Gulf	19	5	10	28		1		63		63	59	71	396,561	313	247	+ 26.7	1,787,841	1,426,601	59	55	61
Dist. 3 Upper Gulf	72	4	9	44				129		129	124	145	810,855	609	644	— 5.4	3,761,132	3,687,500	142	135	137
Dist. 4 L Gulf-S.W.	72	3	10	40				125	3	128	130	144	643,410	650	668	— 2.7	3,270,416	3,160,032	136	119	130
Dist. 5 E. Central	14	1		20				35	3	38	28	23	143,856	190	75	+153.3	697,315	326,088	34	26	23
Dist. 6 Northeast	51		7	8				66		66	68	85	327,346	305	266	+ 14.7	1,517,926	1,260,697	39	34	33
Dist. 7-B N. Central	99		5	120	2			226	2	228	255	159	573,773	1,060	766	+ 38.4	2,938,576	2,191,151	197	173	132
Dist. 7-C W Central	71	1	1	32				105	6	111	108	56	462,111	566	332	+ 70.5	2,394,474	1,382,479	176	146	85
Dist. 8 West	235		1	57				293	8	301	330	379	1,572,947	1,614	1,674	— 3.6	8,679,545	9,022,696	502	498	532
Dist. 9 North	142	2	1	101	2	1		249	2	251	281	307	818,185	1,247	1,428	— 12.7	3,702,384	3,995,462	257	234	224
Dist. 10 Panhandle	21		14	9				44		44	84	68	186,084	342	406	— 15.8	1,091,837	1,273,336	97	86	115
Utah				4				4		4	3	1	17,614	12	8	+ 50.0	44,927	27,572	18	12	7
Virginia																			1	1	1
Washington															2			16,032			
West Virginia	6		23	10				39	1	40	34	66	119,205	250	258	— 3.1	723,975	633,107	202	195	284
Wyoming	45			18				63		63	55	50	324,102	280	221	+ 26.7	1,403,317	1,108,078	99	106	53
Total U. S.	1,839	30	239	1,402	86	8	4	3,608	65	3,673	3,465	3,898	13,835,074	17,029	16,647	+ 2.3	64,741,504	61,249,098	4,831	4,600	4,518

Safety Program Can Promote Multiple Benefits

By D. M. FARRELL, Assistant Area Manager
Texas Gulf Coast Area, Shell Pipe Line Corporation, Houston

ANY organized safety program merits a key place in the management plan because, judiciously handled, it is an exceptional tool for improvement of profits. It affords the manager a ready entree among his workers to promote many conditions beneficial to the business. It is unique because the workers respond through awareness of reciprocal benefits.

Some of the factors that can be improved through a well-planned and carefully-administrated safety program include effectiveness of supervision, employe relations, customer acceptance, public relations, productivity, service continuity, reduction of waste, and reduction of absenteeism.

Experts say that good industrial relations require effective two-way channels of communication between workers and management. Such are imperative if a manager expects to sell the company and its policies to his workers, and if he is to be honestly apprised of—and in a position to respond to—their attitudes, problems and needs.

Following are some of the channels used to achieve individual job safety through communications among Shell Pipe Line Corporation's 1500 employes who operate the 6300 miles of pipe line in the company's Southwest system:

PROPERLY HANDLED, a safety program can promote not only the safety of workers but also numerous additional important benefits for employes and company. With advantage to all concerned, the program can improve employe relations, productivity, service continuity, customer acceptance, and public relations, and can help reduce waste and absenteeism. The safety program can provide these benefits by bringing workers and management closer together and promoting mutual understanding and cooperation.

- Safety chapter meetings
- Poster services
- Monthly accident reports
- House organ articles and editorials
- Fire-fighting demonstrations
- First-aid training
- Supervisory training
- Employe training
- Instruction by foreman
- On-the-job safety meetings
- Letters from general management
- Suggestions by area safety engineers
- Instructions by area and division superintendents.

Time will not permit a discussion of all these in their entirety; however, take a quick look at those considered most effective.

The best channels of two-way communications are provided by the Safety Chapters. Twenty-nine of these have been organized by our safety engineers along the pipe line to include all rank-and-file workers and their direct supervisors. Formed by a conveniently adjacent group of about 50 employes, each chapter elects officers annually who conduct formal quarterly meetings. These meetings are held at night on employes' time, but company transportation may be used. Division, area, and head office supervisors are always invited.

The meeting programs vary. Two each year include dinners and a picnic largely financed by the company. The meetings usually feature two or three items such as a short talk by a local citizen, a description or discussion of a company policy, the showing of a selected motion picture or the presentation of service and safety awards, plus a brief talk on safety. The last is fol-

Family-night safety meeting of Shell employes.

On-the-job safety meeting.

lowed by a general and frank discussion of any unsafe local conditions. Minutes are written and mailed to all concerned.

Supervisors join in the safety discussions, and the superintendents are expected by the management to soon correct any unsafe conditions. Often other irritating working conditions are brought out and discussed freely at the meetings and corrective action taken. Consequently, the independent union councils or "grievance committees" have little on their bimonthly agendas but special seniority cases and general matters.

It has been pointed out that most employe unrest foments from a pyramiding of small grievances. The safety chapters literally "hire a hall" where sorry physical and supervisory conditions can be aired and nipped in the bud. When workers and supervisors—at times with their families — meet freely off the job, a camaraderie and mutual respect develop that are priceless on the job. Company policy is best understood and appreciated when it can be explained to the workers informally. Opportunity for both is provided by the chapters.

Thus in the safety chapters an ideal atmosphere is created for promoting the common interests of employe and employer. Social bonds are fostered within the business. The employes can "blow off steam" about their working conditions without fear of reprisal and with hope of improvement if warranted. The management can sell company policy as well as the company to the employes, and convince them that they personally benefit by becoming ambassadors of good will in dealing with the customers and selling the company to the public.

The safety chapters are organized under Robert's Rules of Order and officers are elected by each group annually without distinction between supervisors or workmen. Following the election of officers in December for the ensuing year, they are concentrated in a group in January when they receive four days' training to qualify them for leading their group. This training, of course, is done at company expense. All safety chapters operate under common bylaws.

Safety Meetings

Very effective channels for work improvement are on-the-job safety meetings. These are held by each foreman with his crew of workers the first few minutes on the job each Monday morning. He has at hand a mimeographed safety message prepared by the superintendent or the safety engineer that can be read aloud to the crew in two or three minutes. Each message aims to provoke several minutes of discussion by the crew members in its application to their current work problems.

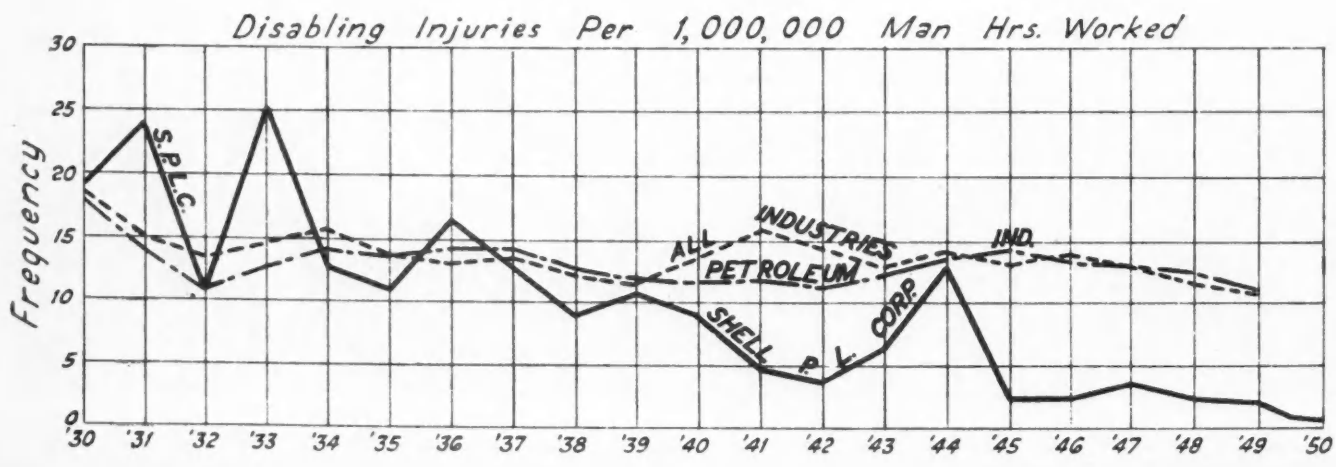
A typical on-the-job subject is "The Right Way Is the Safe Way." This tells that the foreman should teach his crew members how to do the job correctly so they will not get hurt; also that if he does this in the first instance they will not have to unlearn dangerous and wasteful methods. Another example is "You Are Your Brother's Keeper." This stresses that each crew member (including the foreman) should think of his fellows' safety as well as his own. The idea prevents accidents but better yet, it promotes good man-to-man relations on the job, establishing the workers' respect for and confidence in each other as well as the foreman. In short, it fosters team spirit.

Other examples are "The Value of an Explanation" and "The Value of a Question." These point out that men will work more safely and wholeheartedly if the foreman explains the purpose of each job and why it should be done in a certain way. Too, these prompt the workers to ask about jobs they don't understand. Each maintenance and construction crew also spends a few minutes at the start of each new job, regardless of the day or hour, discussing any hazards of the job, the locale or the work equipment and special precautions to be taken. While safety is the theme, much waste of time and material is thereby avoided. Oil losses and pipe line shutdowns are minimized.

These discussions keep the foreman on his mettle. In fact they put him "on the spot" and provide a neat gauge of his effectiveness as a supervisor. The foremen have measured up to this challenge because they have been prepared for it. They have attended conferences on company policy and the principles of supervision, and they have received special training in job relations, job instructions, and job method improvement. They believe the safety program directly benefits them, too, because they receive from management more help in job planning and keener appreciation of their many responsibilities.

The value of the on-the-job safety meetings for the promotion of service continuity, productivity and waste reduction lies in the fitness of the place and time for selling these directly applicable ideas. On-the-job meetings were started during the war-time tempo when our accidents were increasing. They brought an immediate reduction. Productivity in our business means more barrel-miles of oil transportation. Employes have been able to boast of new record line throughputs by attaining better and better service continuity. This latter is the payoff for utility companies, common carriers and other firms producing service instead of goods.

Shell Pipe Line Corporation Accident Frequency Rates



Equipment inspection tours by safety engineers with the division superintendents afford opportunities to improve morale. Periodically they visit company stations, tank farms, field batteries and maintenance and construction jobs to inspect safety equipment and check for hazards. Their fresher perceptions often detect unsafe conditions unnoticed or tolerated by the local personnel. The safety engineers are able often to bolster any flagging morale of supervisors and workers on isolated jobs through friendly discussion.

First-aid training classes are especially fine media for making company boosters and follow the training technique prescribed by the U. S. Bureau of Mines. The training is taken voluntarily by employes on their own time and is offered them every other year.

Similar classes are open to interested members of employes' families at each station. With three days to work with each class, instructors are able not only to give Schaefer's Method its due but also to build company spirit in the home.

The public's opinion of a company is determined in no small degree also by employe actions. The automotive safety campaign is effective not only to cut down insurance and repair costs but also to promote safe and courteous driving on the highways. This is a substantial bid for public good will.

Personal safety contests provide the means for reducing absenteeism. These instill a competitive team spirit not only in preventing accidents but also in keeping the workers on the job. Whether or not a minor injury results in lost time usually depends on employe attitudes. One injured worker may elect to lay off a few days whereas another hurt even more seriously will continue at work through the competitive urge and the concern of his fellows as well as his own for their team safety record. Our company-wide record of but one lost-time injury out of every nine accident cases exemplifies the idea.

It is said that "Statistics Speak for Themselves" and "Records Don't Lie." Thus, look at Shell Pipe Line's outstanding safety records established in recent years.

Safety Awards

Special safety awards received by employes in recent years are as follows:

1946—National Safety Council Distinguished Service Award for working 1,788,000 manhours without a disabling injury.

1947—Four Joseph A. Holmes Awards from the United States Bureau of Mines.

1948—National Safety Council Distinguished Service Award for working 1,273,000 manhours free of disabling injuries. One Joseph A. Holmes Award.

1947-1948—First place in National Safety Council Personal Injury Contest.

1948-1949—Second place in National Safety Council Personal Injury Contest.

1949—First place in National Safety Council Personal Injury Contest. Five Joseph A. Holmes Awards.

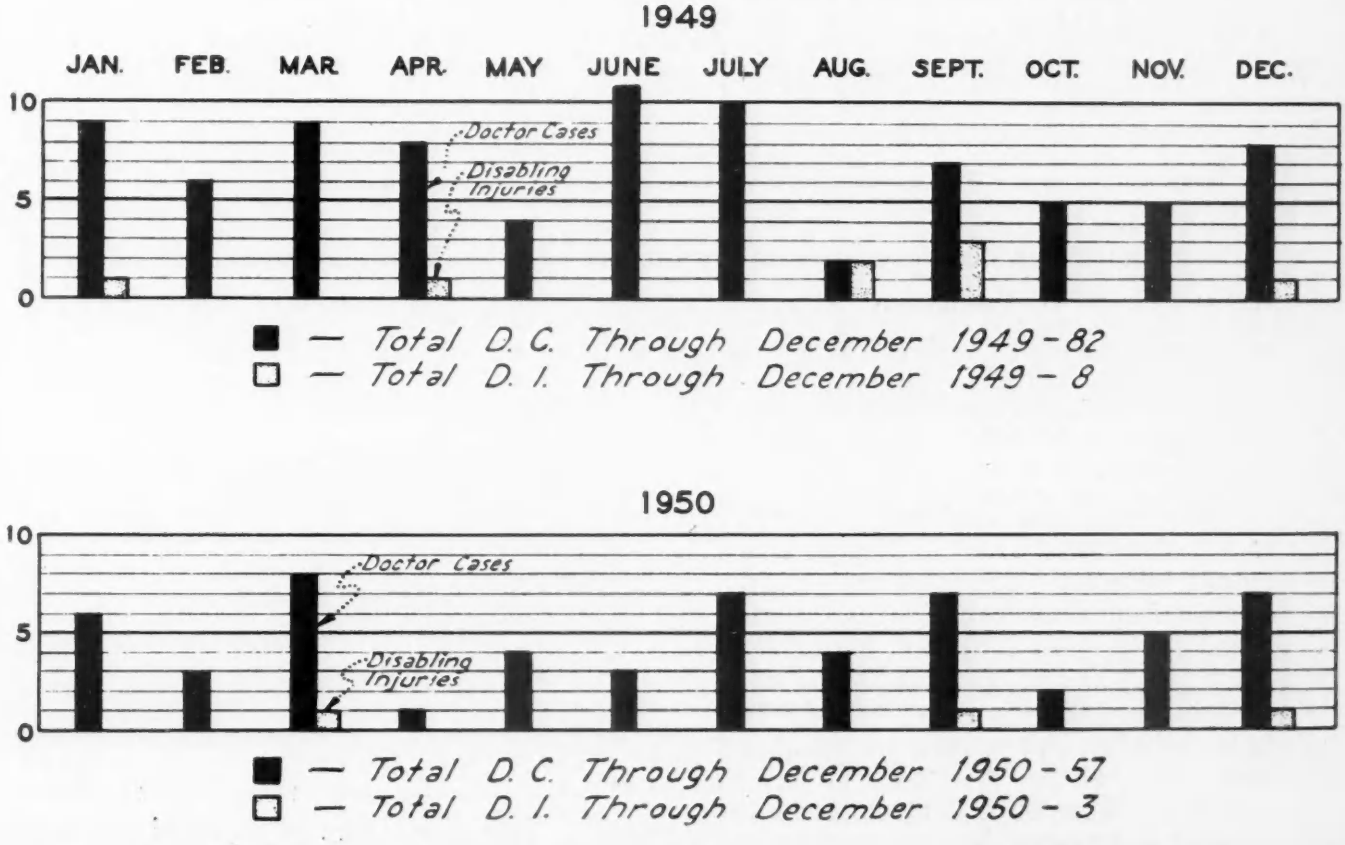
1950—Now in first place in abovementioned contest with an accumulative frequency of 0.84.

1939-1948—Five National Safety Council President Awards received by employes for saving a life.

Employe training, good will building and safety promotion are logical parts of the industrial relations program. In fact they should be predominant parts. Perhaps industrial relations managers should spend less effort arguing with union leaders and more effort keeping and improving the good will of the rank-and-file toward the company.

The unique value of these safety channels will be lost unless a company's personnel policies, such as wage structure, benefit plans, promotional opportunities and grievance procedures, are fair and justly administered at all levels of supervision. But in those companies where the workers are getting a square deal despite other misrepresentation to the contrary, the safety program affords exceptional opportunity to convince the workers of the facts.

Personal Injury Experience


1949
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
10
5
0
Doctor Cases
Disabling Injuries
■ — Total D. C. Through December 1949 - 82
□ — Total D. I. Through December 1949 - 8
1950
10
5
0
Doctor Cases
Disabling Injuries
■ — Total D. C. Through December 1950 - 57
□ — Total D. I. Through December 1950 - 3

4 WAYS YOU CAN lower DRILLING COSTS

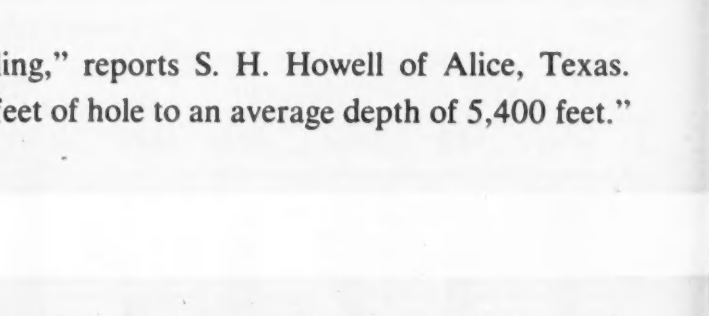
"We cover a lot of territory with our Cardwell 'Trailerig'," reports Curtis Singleton of Corpus Christi, Texas. "In a 90-day period, we drilled eight wells to an average depth of 4,000 feet, moving our 'Trailerig' a total of 600 miles between wells."

"We keep ahead of competition with low-cost moves," reports Big Six Drilling Company of Houston. "The total paid-out expense of moving our Cardwell 'Trailerig' five miles, including tear-down and rig-up time, has been as low as $300.00."

"Our customers like fast moves and fast drilling," reports S. H. Howell of Alice, Texas. "In a 30-month period, we drilled 350,000 feet of hole to an average depth of 5,400 feet."

"Low maintenance costs mean extra profits for any operator," reports McIntyre & Webster, Ltd., of Edmonton, Alberta. "After 24 months of continuous operation, the maintenance on our Cardwell 'Trailerig' is approximately 1% per year of the rig's cost."

In every way, this Cardwell "Trailerig" is a better buy. The "Trailerig" combines a full scale 5,000-foot, twin-engine, double-drum draw works including mud pump drive, with a 90-foot, 200,000-lb. mast (79,810 lbs. gross weight), or a 96-foot, 150,000-lb. mast (67,663 lbs. gross weight). All drives are equipped with Cardwell air friction clutches to provide fast, smooth control. Send for catalog and prices; or see your nearest Cardwell representative.



In roading position the "Trailerig" is only 8 feet wide, 13½ feet high and 59 feet long.

By J. L. STACKPOLE
Iron Drilling Company, Tulsa

NEXT to actual expenditures involved in development of oil and gas properties, the largest single investment which oil and gas companies as well as independent operators have on their books is represented by equipment, which in this article will be designated as "materials." Proper handling of materials and adequate records are of the utmost importance. Improper handling and records can cut revenue seriously.

Where operations are on a small scale the operator or his production department may control the physical movement or handling of materials and his accounting department can handle the records. But where more extensive operations are involved, a Materials department should be set up. In either case there are certain fundamental principles that apply to the correct and economical method of handling and accounting for this investment.

The materials section of an oil and/or gas producing company is primarily a Service department as it serves the Production department in obtaining, handling and disposing of equipment. It serves the Accounting department by furnishing it with the details necessary to book the many transactions involved in developing and operating an oil and/or gas property. It serves the Ad Valorem Tax department by furnishing much of the information it needs to make correct tax renditions. It serves or works in conjunction with the Tax department in handling or disposing of materials to the best tax advantage of the company. It serves the Lease and Land departments in working out trades and deals as well as keeping them notified when all equipment is removed from an abandoned lease so they can execute a release. Inasmuch as the Materials Section works with and serves these various departments its records, as well as the physical handling of materials, should be kept and conducted in such manner as to be of actual service to the departments. Otherwise considerable confusion and financial loss may be experienced by the operator.

Since the duties of the Materials Section are so closely integrated with the actual operations of an oil property, it should be under the supervision of or be a part of the Operating or Production department and act as a liaison between it and the other company sections or departments.

Obviously, the personnel of the Materials Section should have a complete knowledge of the correct names and functions of the various materials and equipment used in oil and gas operations, as well as the price and present market value of both new and used equipment. They should be familiar with accounting practices and procedures, simple tax regulations and contract agreements that govern the operations of jointly-owned properties, as well as have some knowledge regarding the drilling, equipping and producing of oil and gas wells.

Since all operations of an oil and gas property are so closely tied in to materials control, a detailed and intelligent set of records should be maintained in the home office and in each division or district office and they should be readily accessible. In order to maintain these records and thereby furnish the required information to the other departments of the company, suitable forms should be worked out and adopted for general use throughout the organization. They should be uniform and set up in such manner as to provide necessary and complete information to the home office with the minimum effort. While complete, such forms should be as brief and concise as possible.

The operator should give careful consideration to the preparation and adoption of forms to be used in materials control work. Some organizations, it must be noted, are overstocked with forms which in turn cause much unnecessary work and duplications and result in excessive overhead.

During the years the writer has been connected with materials control practices he has found that in actual handling of equipment three basic forms should be used:

- Field or Emergency Purchase Order.
- Materials Transfer.
- Receiving Record.

The Field or Emergency Purchase

IT IS important to the oil or gas operator to keep adequate records of equipment and materials and to properly handle and control the materials. Improper records and handling can seriously reduce profits. All pertinent information required for efficient and economical operations can be maintained through use of three basic forms, here discussed, showing purchase, distribution, and movement of materials on a producing lease or property.

Order (Figure 1) is designated for materials purchase in the field and is usually issued by some member of the Materials Section and signed by the district foreman. Before issuing this order the Materials Section should determine beforehand if the equipment is available, if it is in good condition and correctly priced. This order should by no means be a "blank check" to field personnel. This form should be numbered serially and should show what equipment was purchased and who was the vendor; date of purchase; quantity; where it is to be charged; and for what purpose it is being used. Field purchase orders should be carefully scrutinized before issuance and some method of internal check should be devised to avoid issuing of duplicate orders and to prevent fraudulent use thereof. The individual operations of the company will determine this method of internal check. The example included as Figure 1 may be changed to suit the needs of the individual operator or company.

To Field Supt.
This Copy to be Forwarded to Home Office when Issued.

XYZ OIL CORPORATION

PURCHASE ORDER _____

TO _____

ADDRESS _____

DATE _____, 19____

Quantity	DESCRIPTION	TO BE CHARGED TO		
		LEASE	Well No.	Material Used for

By _____
Party Authorized to Issue Orders

FIGURE 1. Sample field purchase order.

The Materials Transfer Form (Figure 2) is probably the most important form used by the Materials department from an accounting standpoint. This form provides detailed and complete information regarding the movement of equipment from one account to another. This may be from a warehouse to a lease, from one lease to another, from well to well, etc. Transfers should be numbered to avoid skipping or losing track of any materials moved. The form should show to what account the equipment is to be credited and charged, show quantity and description, condition of equipment such as new or second hand, what the equipment is to be used for and, should its original use be diverted, show where and for what purpose it is ultimately used. Space should be provided on the Materials Transfer Form for price and value of individual items of equipment transferred from one point to another. Of course it should bear the date the equipment was actually moved so that the transaction can be tied in with trucking charges, lease operations expenditure, etc. This is most important where a partner is involved in the operation of the lease or warehouse.

XYZ Oil Corporation

Condition
A 100%
B 75% of New—Good Second Hand
C 50% of New—Fair Second Hand
D 25% of New—Bad Order
C Junk

TRANSFER OF MATERIAL REPORT
Transfer No. 00000

Shipped Via _____ **Ordered by** _____ **Date** _____

From _____ **Was Used For** _____

To _____ **To Be Used For** _____

Quantity	ARTICLES	Code	Condition	OFFICE USE ONLY	
				Unit Price	Amount
	Total				

Below for Office Use Only

Priced by _____

Calculations correct _____

Distribution _____
Posted to Stock Ledger _____

Feature	Debit	Credit

Authorized by _____

Prepared by _____

FIGURE 2. Sample of transfer of material report.

In cases where average costs are carried on warehouse stock items a different type of Materials Transfer Form should be used, with columns to show the present market price and the average cost price of the materials transferred. This type form is of particular value in moving equipment to joint operations, as most operating contracts call for current market price of equipment, whereas it is good accounting procedure to credit materials at cost from a stock account. (The example of this Form

This copy to be Mailed to Home Office when Material is Received

RECEIVING RECORD

PURCHASE ORDER _____

TO _____

ADDRESS _____

DATE _____, 19____

Quantity	DESCRIPTION	TO BE CHARGED TO		
		LEASE	Well No.	Material Used for

Above Received by _____

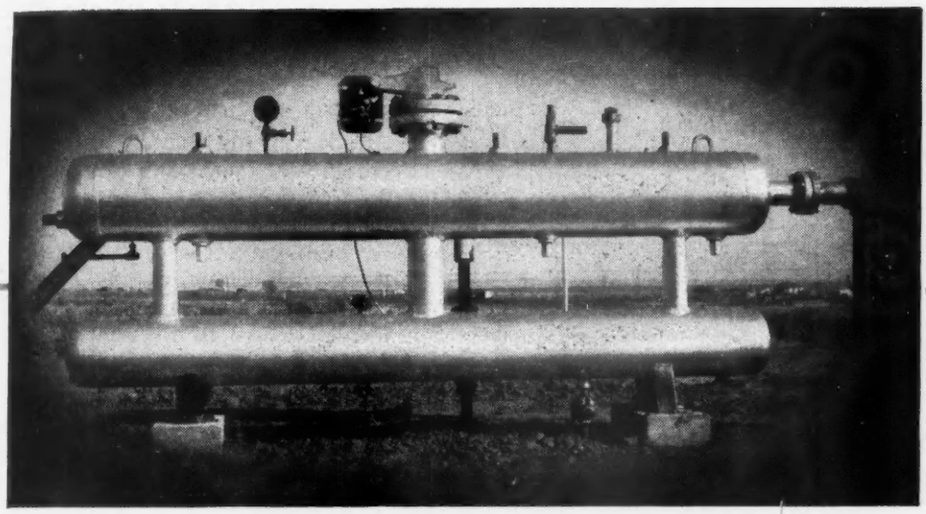
Date _____

FIGURE 3. Sample of receiving records form.

More Gas...and Liquid...Volume

BS&B Horizontal Separator...

The Engineered "Bump" on the Flow Line



- Engineered for high capacity and efficiency by combining:
  - Centrifugal force for initial separation.
  - Streamlined horizontal travel for gravitational separation.
  - Efficient mist extractor for final scrubbing.
  - Rugged dependable BS&B controls.
  - Ease of installation.

Horizontal separator capacity is a function of horizontal travel as well as velocity. Save by using BS&B Horizontal Separators!

BLACK, SIVALLS & BRYSON, INC.
OIL AND GAS EQUIPMENT DIVISION
2131 Westwood Blvd., Rm. 38
OKLAHOMA CITY, OKLAHOMA

BS&B has grown with the Petroleum Industry, designing and manufacturing efficient, dependable equipment for over 58 years. BS&B leadership continues, now and in the future!

BS&B HORIZONTAL OIL-GAS SEPARATORS

shown as Figure 2 can be modified to meet this type operation.)

The practice of keeping average costs of materials in a warehouse is generally required by public auditing firms, especially in the case of stock companies where stock is held by the public.

The Receiving Record Form (Figure 3) is least used and is primarily intended to advise the home office that equipment purchased as shown on the Field or Emergency Order (Figure 1) has been duly received.

This form should show quantity, complete and detailed description of condition of equipment at time received in the field, the Purchase Order it applies against, and the account to which it must be charged, as well as other information which in the opinion of the superintendent or foreman would be of value to the home office.

With the use of the above three forms a complete set of records can be set up in the district or division office. These records will show the amount of materials charged to each account such as the different leases or warehouses in the district. Since the field personnel are primarily interested in the physical use of the equipment it is not necessary to maintain prices and costs in the field set of records.

A practical method for maintaining materials control is the loose leaf card system which affords a quick reference and is recommended by the writer over the regular card index system which is sometimes used. One advantage of the loose leaf system is that it eliminates the possibility of misplacing cards in posting and refiling since cards need not be taken from a box or drawer. The loose leaf system is in effect a "card book" where cards are filed and which can be used in taking inventories without the possibility of losing the cards. In most cases cards are arranged alphabetically, but they can be arranged in any other method that best serves the departments interested.

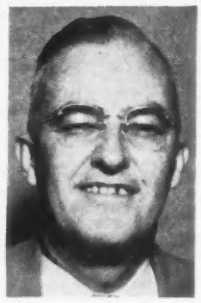
Figures 4 and 5 are sample cards that can be used and modified to fit the requirements of the individual company or operator.

If Materials Control records are properly kept, posting costs should be nominal and overhead expenses appreciably reduced. The Petroleum Accountants Society of Oklahoma has compiled a complete list of materials to be controlled. This list covers only important major items of equipment and is used as a basis by most companies for their Materials Control records as well as for inventory adjustments for Joint Ventures and inventory adjustments alone.

A corollary to accurate Materials Control Practices is the necessity of maintaining proper inventories of all physical assets on a lease or property.

It is as important to inventory warehouse stocks and lease equipment periodically as it is to audit the

About the Author



JOE L. STACKPOLE started in the oil business with Tom Slick and was in charge of Slick's purchasing and material accounting throughout some of the famous Oklahoma oil booms. He handled millions of dollars worth of materials and equipment and perforce had to work out his own systems to keep track of Slick's far-flung operations. Stackpole joined Transwestern Oil Company in 1936 when it acquired the Slick-Urschel interests and when the latter were acquired by Sunray Oil Corporation in 1946 he joined Sunray and moved to Tulsa. Shortly afterwards he resigned and is now with Iron Drilling Company, Tulsa.

Date	Voucher No.	Invoice or Transfer No.	From Or To	Serial No.	Location	Pcs.	Quantity Balance	Cond.	Price	Amount	√
Sheet No.			Form M-5						Forward		
Farm Name			Article								
Interest											

FIGURE 4. Sample of card index form for material control (other than tubular goods, since it shows pieces of equipment only).

Date	Voucher No.	Invoice or Transfer No.	From Or To	Location	Jts.	Feet	Quantity Balance Jts.	Quantity Balance Feet	Cond.	Price	Amount	√
Sheet No.			Form M-4							Forward		
Farm Name			Article									
Interest												

FIGURE 5. Sample of card index for material control (for tubular goods only, since there are columns showing "joints" and "feet").

It doesn't have to be this way...

WATCHING THE BOSS TRYING TO SNEAK IN SO HE CAN ENJOY THE LAST FEW HOURS OF HIS VACATION BEFORE THE GANG GETS TO HIM WITH TWO WEEKS OF ACCUMULATED GRIEF.

WAIT TILL HE HEARS ABOUT THAT STRIPPING JOB THAT'S BEEN GOING ON AT MINCKLER 5.
AW, THAT AIN'T HALF BAD, WATCH HIM DROP DEAD WHEN HE FINDS THAT BUSTED RODS HAVE PUT THE O'CONNOR LEASE A WEEK BEHIND ALLOWABLES.
THE ONLY THING THAT HASN'T GONE WRONG AROUND HERE IS ME. I JUST KEEP ON PRODUCIN'

It can be like this!

WHAT HAPPENED WHILE YOU WERE GONE? NUTHIN! THESE FREE PUMPS RAN JUST AS GOOD AS IF YOU WERE HERE. SURFACED NO. 8, INTAKE WAS PLUGGED, BUT THE WELL WASN'T DOWN MORE THAN 3 HOURS AND WE MADE THAT PRODUCTION UP EASY BEFORE THE NEXT DAY.

..Free Pumping Makes the Difference!

It's easy to figure why there is no slump in production during the vacation season if your property is equipped with Free Pumps.

Imagine how simple it is to cover vacation schedules when the relief pumper has to make only *one stop* to check all wells on a lease. There, at the central power controls, he observes, adjusts, and regulates the pumping of every well. There, also, is where he takes care of all engine maintenance for the entire lease.

Even if a well goes off, he can round-trip the bottom hole pump—the Free Pump—and it takes less than one hour of his time.

It is in ways like these that Free Pumping multiplies the effectiveness of your operating labor. They explain why you get maximum flexibility in arranging vacation schedules so production won't suffer. They explain, too, why Free Pumps will lower your pumping operating costs by 25% to 50%.

Even with all its extra service features, the Free Pump system frequently costs less to install than any other pumping system. If, therefore, you want to be certain of getting the best and the most for your pump equipment dollar, call your nearest Kobe representative.

Free Pump
KOBE
ONE OF THE DRESSER INDUSTRIES

KOBE INC. Division of Dresser Equipment Co. *General Offices:* Huntington Park, California. *Division* and *District Offices:* Avenal, Bakersfield, Huntington Park and Ventura, California; Great Bend, Kansas; Hobbs, New Mexico; Healdton, Oklahoma City, Tulsa, Oklahoma; Brownfield, Corpus Christi, Fort Worth, Houston, Kilgore, Odessa, Snyder, Texas; Casper, Wyoming; New York City.

Accounting department records and reconcile the bank statement.

Stock points should be inventoried annually and producing leases as often as necessary depending on the development of the property. Old settled production need not be inventoried as often as an area where there is more activity and development.

Inventories should be posted to the Materials Record and can be used to determine overage and shortages of materials, check joint operations, and serve the Engineering department by supplying information as to lease lines, plats, etc. They can be used for future reference in the many problems concerning the operating, producing and salvaging or sale of an oil and/or gas property. Obviously, an inventory serves as a check for theft or misuse of company funds or equipment. In fact, it can furnish valuable information to all departments of an operating company.

A simple method to inventory a producing property so as to avoid missing any material or equipment is to start with Well 1, first marking down the subsurface equipment such as casing, tubing, packers, liners, bottom-hole pumps, sucker rods, etc. Then set down the surface equipment such as wellhead fittings, pumping units, etc.

Next run the oil line from the well head to the junction with the oil lines from other producing wells on the property. This junction may be a manifold, a separator, a receiving tank or some other common point where the oil from the various wells is combined.

After completing the inventory from the first well to this common junction, inventory all remaining wells in the same manner—from the bottom of the hole to this common junction of the oil lines.

After the wells are inventoried follow the flow of the oil to the pipe line connection or sales point, listing each item in detail as separator, receiving tank, batch tanks, oil header, etc.

If a property is so large that it has more than one sales point or tank battery, inventory each group of wells that produce into a common tank battery as a unit.

After completing the inventory of all material used to produce the oil and transport it to its sales point, inventory all auxiliary equipment and systems such as gas, fuel and/or water treating systems, camp, tool house, well servicing units, idle equipment, etc.

Since a large portion of an oil or gas company's investment is in equipment it might be well to emphasize that all departments should cooperate closely with the Materials Control section. For example, if management should decide to abandon a property it would be well to study its book investment by referring to the Materials Section records. Management can then consult with the Operating and Tax departments to determine if the property should be abandoned and the material salvaged or if it should be sold for a cash consideration or traded for material that could be used in future operations.

From such studies the Income Tax Section can advise which method would benefit the company and effect a saving in taxes.

Another important function of the Materials Section is to furnish facts and figures to other departments relative to costs, present values of equipment, and the use of material to be salvaged, and suggest the different types of trade deals or sales that can be worked out most profitably and estimate the probable net receipts that may be received in cash or equipment.

Another example of the importance of close cooperation between the Materials Section and other departments is furnished where joint inventories are taken of properties owned jointly by two or more individuals or companies. The individual participating in the joint inventory can furnish information to the Partnership Section regarding operating practices, costs, etc. He can furnish the Production department with information regarding production methods, type of material used, and other operating practices and problems of their operating partner and/or partners. Thus, the information obtained from a joint inventory can be used by all departments of a company involved and interested in the joint venture.

The different operating practices of individual operators and companies may require other forms and variations of those presented in this article. However, by using those which have been discussed as a basis, all pertinent information required for efficient and economical operations can be obtained to show the purchase, correct distribution and movement of materials on a producing lease or property.

Safety Record Best In Industry History

THE petroleum industry in 1950 achieved the best safety record of its history, according to the annual survey compiled by the Department of Statistics, The American Petroleum Institute.

The study shows that the chances of an oil employe being injured fatally or permanently disabled now are about 5900 to 1, against an average of 4400 to 1 in 1949 and 2800 to 1 in 1946. The number of employes fatally injured or permanently disabled during 1950 was 81, a 26 percent improvement over the 109 reported for 1949.

The past year was the fifth consecutive year in which a decrease in accident frequency and severity was recorded, and the second in which the record bettered the previous lows established in prewar years. During the war, injury rates increased disproportionately because of the shortage of skilled manpower and the constantly increasing tempo of production and output.

The 1950 survey covered 477,925 employes in 265 companies working 1,007,694,000 hours.

The frequency rate of injuries last year fell to 10.08 per million man hours worked, a decrease of 4.4 percent from the 1949 rate of 10.54. The chances of an oil employe being disabled by injury in 1950 were 47 to 1, compared with 45 to 1 in 1949 and 34 to 1 five years ago.

The severity rate of injuries for the first time dropped below one day lost per 1000 man-hours worked, falling to a figure of 0.84 compared with 1.03 the year before.

The greatest improvement in safety performance last year was among refinery workers. There, the severity rate (the number of days lost per 1000 hours worked) was more than cut in half, dropping from 1.22 to 0.60. The number of workers fatally injured or permanently disabled fell from 42 in 1949 to 15 in 1950. The refinery survey covered 147,990 workers, the largest single group included in the study.

In 1920 the API set up a committee to serve as a clearing hourse for the safety information and programs developed by its members. Through it, oil companies are encouraged to intensify their own safety programs and to pool their safety knowledge so that it can be shared by all.

SPEED and ACCURACY in directional surveys

FOR CASED OR UNCASED HOLES with SURWEL Multishot Surveying Service

THE SPERRY-SUN SURWEL is the only directional well surveying instrument that can be operated on a line inside the casing. That's a timesaver because wells can be surveyed while waiting on cement to set after running casing. When operating on a line only about 30 second stops are required for each record.

If preferred SURWEL can be run on drill pipe. Here again it is a timesaver because the survey can be made at normal operating speed.

The design of the SURWEL makes it possible to use it where heat is so great that other instruments fail. The length of the instrument insures accurate alignment in the hole.

SURWEL surveys are fully computed including vertical depth correction. The Service Report includes a horizontal projection of the course of the well, the film records and original computations.

SURWEL (Gyroscope) Multishot Surveying Service is your assurance of accurate, fast directional surveys by efficient, specially trained crews.

SPERRY-SUN WELL SURVEYING COMPANY

3118 BLODGETT AVENUE HOUSTON, TEXAS

Philadelphia, Pa. Falfurrias, Odessa, Marshall, Texas Long Beach, Ventura, Bakersfield, Calif.
Oklahoma City, Okla. Lafayette, La. Moulden Oil Field Services, Casper, Wyo. Crossville, Illinois

Improved Proration Would Expand Reserves

By PARK JONES
Consultant, Houston

THE U. S. oil future can be materially improved by a modified plan of applying existing conservation laws so that the drilling of unnecessary development wells would be avoided. This would permit the drilling of a greater number of wildcats and discovery of more new reserves without increasing the industry's financial burden. Engineers should formulate the plan for lawyers. The plan should minimize physical and economic waste, protect correlative rights and (for proration states) allocate oil allowable equitably and the gas take ratably.[1]

The probable oil future under the prevailing method of applying conservation laws can be indicated for the purpose of comparison with a modified plan as follows:

Basis, 50,000 Total New Wells Per Year

Number of wildcat wells per year 10.000
Oil discovered, barrels/year .. X
Non-wildcat wells/year 40,000
Barrels of oil per non-wildcat well X/40,000

Under the prevailing plan, operators are often required to drill wells near oil-water contacts, near gas-oil contacts, and on small tracts. Unnecessary production of water and free gas reduces reservoir pressure and the flowing capacity of the wells not producing excessive water or free gas. Unnecessary wells are usually abandoned when invaded by water or gas.

It is estimated that at least seven of 40 non-wildcat wells currently being drilled in the U. S. would be unnecessary wells under a modified plan of applying the existing conservation laws. The probable future under a modified plan can be indicated for comparative purposes as follows:

Basis, 50,000 Total New Wells Per Year

Number of wildcat wells/year .. 17,000
Oil discovered, barrels/year ... 1.7X
Relative rate of discovery 1.7
Non-wildcat wells/year 33,000
Barrels of oil per non-wildcat well 1.7X/33,000
Relative oil reserve per non-wildcat well

$$\frac{1.7X}{33{,}000} \Big/ \frac{X}{40{,}000} \qquad 2.0$$

Under a modified plan, operators could so locate and complete oil wells as to minimize the unnecessary production of water and free gas.[2] In addition, water or gas could be injected where needed. Consequently, the new oil producing capacity would be at least twice that under the prevailing plan because of the 2.0 per-well relative reserve, higher operating reservoir pressure and a comparatively nominal abandonment of wells during the life of a reservoir.

Comparison of Plans

For a given number of non-wildcat wells drilled annually, unnecessary duplications across lease boundaries under the prevailing plan require more materials (pipe, separators, tanks, valves, etc.) than would be needed under a modified plan. Aside from the higher materials requirement, the two plans may be compared as follows:

	Plan of Application	
	Prevailing	Modified
New Wells per Year, Percent	100	100
Wildcat Wells per Year, Percent	100	170
Annual Oil Discovery, Percent	100	170
Oil Reserve per Non-wildcat Well, Percent	100	200
Oil Producing Capacity per Non-wildcat Well, Percent	100	200 or more
Non-wildcat Wells per Year, Percent	100	82.5
Duplication of Non-wildcat Wells, Percent	17.5	None
In States having Proration, Oil Allowable per Non-wildcat Well, Percent	100	121 or more

The data are based on only seven unnecessary wells per 40 non-wildcat wells or 17.5 percent. But a comparison of the development programs in the U. S. with optimum programs and also with those in other countries indicate that unnecessary wells in many instances are more than 50 percent. The probability is that the percent of unnecessary wells is higher than 17.5 even when new wells for secondary recovery purposes are included in the total non-wildcat wells. The increase in oil allowable per non-wildcat well in a state having proration would be much higher than the said 21 percent if the drilling of new wells for secondary recovery purposes is not a material fraction of the state's total non-wildcat wells.

In other words, the case for a modified plan is obvious, as it would enable operators to ascertain and achieve the optimum development[2] of each field in terms of the attending physical and economic circumstances. Furthermore, the greater number of wildcat wells (17:10) would give geologists much more information for finding structural and stratigraphic-type reservoirs without any additional drilling cost to operators.

Army Engineers

Engineers should formulate for lawyers a plan that would satisfy the development, producing and proration requirements of the respective states. Under the prevailing plan, oil is migrating across lease boundaries underlain by the reservoirs in which oil is being displaced either downdip by an expanding primary or secondary gas cap or updip by encroaching water.

A modified plan should enable landowners and operators to protect themselves against the loss of oil and gas by migration. The plan should minimize physical and economic waste, protect correlative rights and (for proration states) allocate oil allowable equitably and the gas take ratably.[1] The plan would materially improve the U. S. oil future.

REFERENCES

[1] Conservation of Oil and Gas, A Legal History, Published by the Section of Mineral Law, American Bar Association, Chicago, Ill.

[2] Oil and Gas Conservation, Development and Production, A Summary compiled by Park Jones, Gulf Publishing Co., Houston, Texas.

Texas Research Center Aids Oil Industry

By FRED D. THOMPSON
Executive Assistant, Off-Campus Research Center,
University of Texas, Austin

AN expanding program of research of direct benefit to the petroleum industry is detailed in the latest semi-annual report of The Off-Campus Research Center of the University of Texas at Austin.

The Research Center is nine miles northwest of Austin. During World War II it was a government magnesium plant. The University has acquired it to facilitate its increasing research activities. Twenty-six of the former plant's 34 buildings now house 17 laboratories.

Six of them are devoted to oil industry research, J. Neils Thompson, director of the Research Center, reports.

"These laboratories," he says, "provide many research tools for oil men, ranging from tangible samples from thousands of oil and gas wells to radio waves and the bombardment of molecules in electronic instruments."

Thompson maintains that educational institutions have an obligation to conduct such research.

"In a state which has produced more than $17½ billion worth of oil in little more than a half century, the educational system would be negligent indeed if it did not contribute heavily in both applied and basic research to the petroleum industry.

"Problems are encountered frequently in modern oil industry techniques and processes which only research can solve. To assist the industry in the solution of its problems is one of the major goals of University of Texas research."

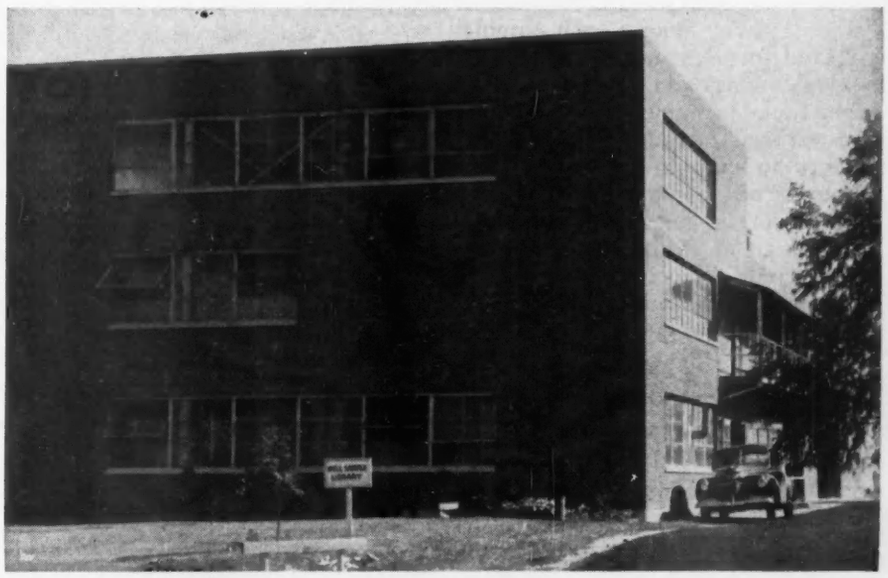
Each of the six laboratories cited is an integral part of some University department or bureau. Three of them —the Well Sample and Core Library, the U. S. Geological Survey Laboratory, and the Mineral Technology Laboratory—are under the executive supervision of Dr. John T. Lonsdale, head of the University's Bureau of Economic Geology.

Activities of the six laboratories are described as follows:

THIS ARTICLE describes an important research program of the University of Texas in a special off-campus laboratory center. Near Austin, the center has at least six laboratories of particular interest to the petroleum industry, including a well sample and core library and a petroleum engineering oil well core depository.

● The Well Sample and Core Library of The Bureau of Economic Geology is one of the largest public collections of its kind in the U.S. It contains 3 million individual samples representing 32,000 oil, gas and water wells in every section of the state. The collection weighs 300 tons and, in length of geologic sections represented, measures approximately 15,000 miles. The library also has a substantial collection of oil well cores. From 150 to 200 oil company geologists make use of the collections in their investigations annually. The well samples are conveniently filed, material is easily located, and visiting geologists and students have the privilege of subjecting the samples to any process of analysis desired. The library is designed to promote a greater knowledge of the geology of Texas by bringing together an extensive range of material. More specifically, it offers a permanent file of subsurface samples which can be worked and reworked as new discoveries are made and new techniques developed. A permanent record also provides additional control points for interpreting the structure and stratigraphy of the state. Also, the educational value of this collection to students and teachers of geology is becoming increasingly apparent.

● The U. S. Geological Survey Laboratory is investigating geological conditions in the limestone reef oil fields of North and West Central Texas. The recent discovery of oil in buried fossil reefs in Scurry County



The Well Sample and Core Library at The University of Texas' Off-Campus Research Center contains drilling samples from 32,000 Texas oil, gas and water wells. The collection is used by many oil company geologists in their investigations.

caused oil companies and educational institutions alike to call for such an investigation. Previously, oil production from reef fields had been limited and therefore little was known about the occurrence of these large porous limestone reservoirs. Now the Texas discoveries and the discovery of oil fields of the same type in Western Canada have stimulated scientific studies of reefs everywhere. A tremendous amount of material is available for study. Recently the laboratory obtained 12 tons of cores from the Texas reef fields, and these are being subjected to basic analysis in an attempt to determine the environment under which the reefs were formed. This may provide a key to the problem of reef occurrence. Considerable knowledge of the occurrence of modern reefs has been gained in recent years by studies in the South Pacific, and it is expected that eventually some of the scientists who have been on these expeditions will be brought in for consultation. As a part of this investigation, outcropping rocks and the animal and plant life they contain also are being studied and mapped. The laboratory's work is a cooperative project and sponsored by the U. S. Geological Survey and the University's Bureau of Economic Geology.

● The Mineral Technology Laboratory is engaged in making analyses, physical or chemical or both, that contribute to or definitely establish the identification and classification of minerals and rocks being studied by the staff of The Bureau of Economic Geology.

Considerable time also is devoted to interested citizens who send in specimens for identification with inquiries as to their possible commercial value. Typical among such samples are sand for glassmaking, limestones, dolomites, clays and spars which have been found commercially valuable, and various rocks believed by prospectors to contain radioactive elements. In order to test the latter, and to perform similar examinations for the Bureau of Economic Geology, a Geiger counter has been added to the laboratory's equipment. Radioactive substances have not been found in Texas in commercial quantities.

In addition to the strictly analytical phase, increasing attention is being devoted to the study of possibly new uses of Texas minerals and rock products.

● The Petroleum Engineering Oil Well Core Depository is contributing to a systematic attack on the problem of increasing recovery of oil from

DR. JOHN T. LONSDALE
Director, Bureau of Economic Geology

Texas oil fields. Nearly 13 billion barrels of oil have been produced in Texas to date. More than 15½ billion barrels are estimated to be in our proven primary reserves. Competent authorities estimate another 15½ billion barrels of oil exist in already proven territory but cannot be recovered by production methods now in use.

The depository contains a complete set of cores from the Woodbine sand of the Cayuga oil field. It is believed to be the only complete set of cores from one field in existence. This material is being studied by members of the Petroleum Engineering department with particular emphasis on determining the number and sizes of pore systems and their classification, and the effect of freezing when cores contain salt water and oil. The practice of core freezing has been widespread for several years because it permits their transfer to laboratories with their full fluid content, but no scientific work has yet been published setting out whether the freeze process affects the porosity or permeability of the core material to the extent that the frozen sample would not be representative of the formation in the field.

J. NEILS THOMPSON
Director, Off-Campus Research Center

● The Mass Spectrometry Section of the Spectroscopy Laboratory brings electronics into the field of research applicable to the oil industry. Research activities of this section are centered about the problem of determining the energies required to ionize molecules and the energies required to break the chemical bonds in the molecules, particularly in hydrocarbons. For this purpose a mass spectrometer is used. Molecules under investigation are bombarded with electrons of controlled energy from which can be determined the ionization potentials of the molecules and the bond strengths of the atoms in the molecules.

Since many refinery operations such as cracking and alkylation involve chemical reactions, and in particular ionic chemical reactions, knowledge of bond strengths and of ionization energies can be of considerable value in interpreting the mechanisms of reactions presently in use and in predicting new reactions which might be of value.

The Emission Spectrographic Section of the same laboratory also employs techniques of widespread practical use. Core samples are analyzed by an emission spectrograph. The data is then correlated in order to obtain variations in depth of production horizons in a particular field. This information enables an operator to evaluate the amount of oil available for production, and tells him where to set pipe to produce it.

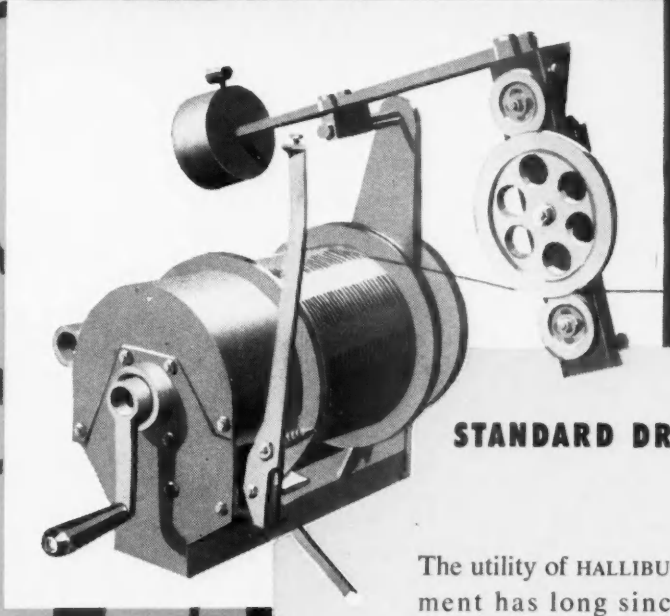
● The Electrical Engineering Research Laboratory since World War II has devoted much of its time to a study of the propagation of radio waves through to lower atmosphere. This work is sponsored by the Office of Naval Research and has a direct bearing on national defense. But information that has resulted from these studies for the Navy is also of interest to the oil industry because of the development of off-shore drilling in the Texas tidelands. As an example, extensive radio wave propagation and meteorological investigations were made by the laboratory's staff along the Gulf Coast and over coastal waters. These were recognized as significant to the industry in that it too is concerned with the propagation of radio waves over the Gulf because of problems arising in such areas as communications, navigation and radar storm detection.

WORLD OIL

EXPLORATION SECTION

L. J. LOGAN, SECTION EDITOR

HALLIBURTON MEASURING DEVICES



STANDARD DRILLING EQUIPMENT

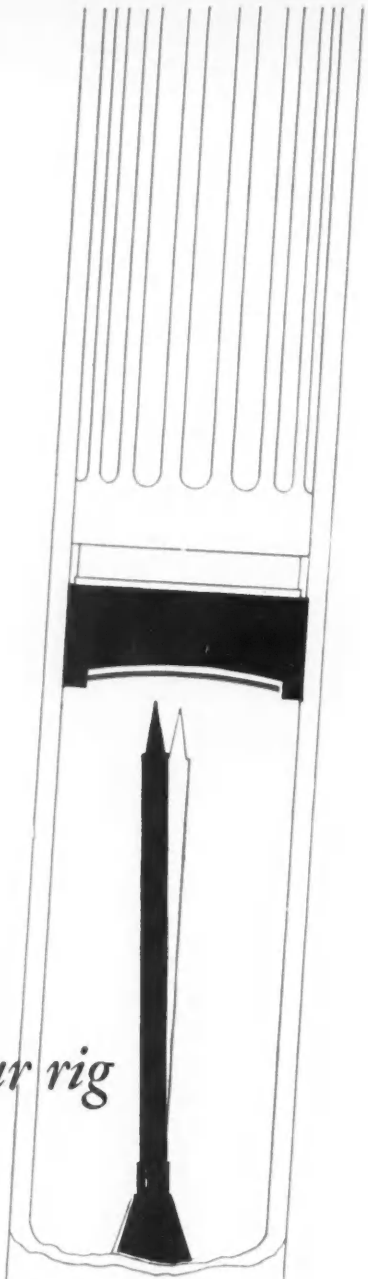
The utility of HALLIBURTON measuring equipment has long since been expanded to hundreds of important uses other than oil well cementing. They've become a standard part of drilling equipment throughout the world. They eliminate guesswork and miscalculations because the Veeder Counter on each HALLIBURTON MEASURING DEVICE reads *exact* depths *directly*. Let your HALLIBURTON representative describe and recommend the types best suited to your problems. *Call him today!*

HALLIBURTON OIL WELL CEMENTING CO.

DUNCAN • OKLAHOMA

ACCURACY

—another reason for Totco on your rig



In controlled vertical drilling, your success depends on the accuracy of your drift indicator. And you can count on TOTCO —it's accurate!

Just look at TOTCO's chart head . . . you'll notice that the recess in this head is concave . . . that the accurately graduated composition chart sits firmly on this curved bottom, forming itself into a perfect arc absolutely concentric to the arc in which the angle indicator moves. This exclusive TOTCO design, small as it may seem, eliminates errors produced by a chart fixed in a flat position and insures absolutely accurate recordings.

All over the world, operators prefer TOTCO design and construction for sustained and absolute accuracy.

Be **SURE** *you know, use* **TOTCO**

TOTCO Recorder

Technical Oil Tool Corp., Ltd.

1057 N. La Brea Ave., Los Angeles 38, Calif.

Exclusive Distributors:

California—The Republic Supply Company of California
Domestic—The Continental Supply Company
Canada—Oil Well Supply Company
Export—Lucey Export Corporation, New York City

Significant Developments in the Four Corners Area

By J. L. TATUM
Consulting Geologist
Albuquerque, N. M.

ONE of the most active oil provinces in the Southwest is the so-called "Four Corners" area where Arizona, Utah, New Mexico and Colorado converge at a common boundary, and where three major basins—the San Juan Basin, Black Mesa Basin and Paradox Basin—are fast developing into important natural gas and oil producing areas. (See map, page 76.)

During the past two years the following significant developments have marked the "Four Corners" area:

- Rapid and widespread expansion of the gas-producing areas in the San Juan Basin.
- Discovery of natural gas on the Ignacio Structure from multiple producing zones.
- Discovery of 59-gravity, sweet oil in the Mississippian at the Table Mesa anticline which discovery was accompanied by a large flow of non-inflammable gas.
- Discovery of the thick and very porous Dolomite beds in the Devonian near Nucla, Montrose County, Colorado, and about 1400 feet of Ordovician Dolomite sands and shales in the same area.
- Discovery of hitherto unknown porous limestone below the salt, west of Moab, Utah.
- Additional evidence of the growth of the salt anticlines during Hermosa, Pennsylvanian time.
- Discovery of definite reef facies in the Pennsylvanian above the salt, south of the Dove Creek area.
- Evidence of important structural movemennts during the Paleozoic, hitherto only suspected by very slight evidence.

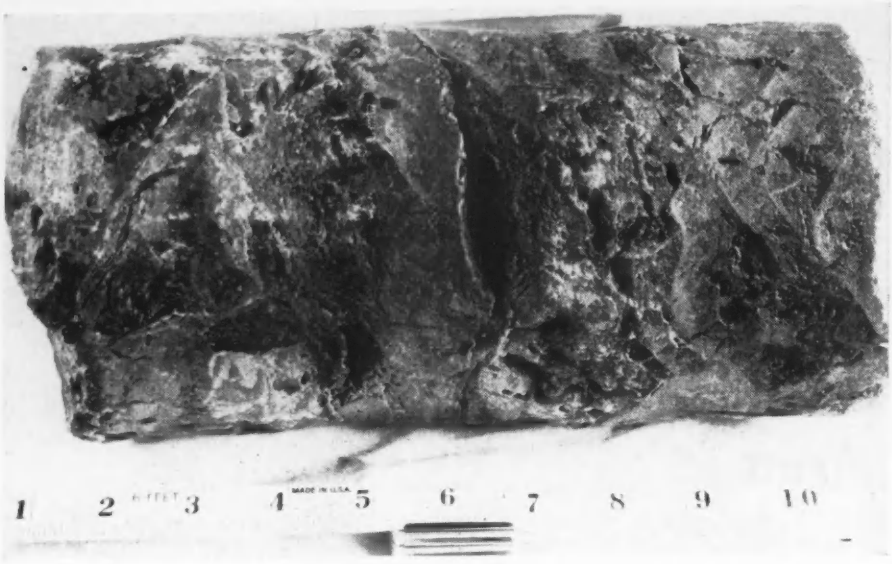
THE FOUR CORNERS area of the Rocky Mountain region is becoming increasingly important as a source of gas and oil. Significant production has been established especially in three major basins. Among recent noteworthy developments was finding of a Pennsylvanian reef containing some oil in the Dove Creek area. Gas development in the San Juan basin is expanding. High gravity, sweet oil was discovered in the Mississippian at Table Mesa. Dolomite beds in the Devonian and Ordovician in Montrose County, Colorado, are thick and porous. Porous limestone has been discovered below the salt near Moab, Utah.

Factors in Development

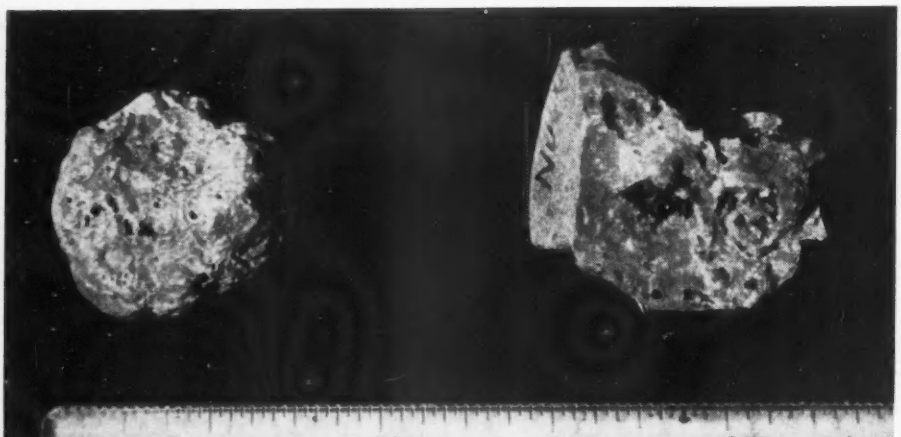
A factor which, perhaps more than any other, has contributed to the accelerated development of the Mesa Verde, Picture Cliff gas areas of the San Juan Basin was the granting of a permit to El Paso Natural Gas Company to build a gas line to California. Another important bearing on this phase of the development was the establishing of an additional Picture Cliff trend west of the Fulcher Kutz Canyon trend, neither of which has yet been defined. The Blanco trend now appears to be proven for an area about 40 miles long and six miles wide but has not yet definitely been defined. In fact, some geologists believe the Mesa Verde Glade trend near the Colorado state line may eventually be a part of the Blanco trend unless it develops into a separate trend which only future drilling can reveal.

Drilling on these trends continues at an accelerated pace. Most of the wells are relatively small, but apparently the operators, of which there are some substantial ones, believe it to be profitable.

Perhaps the most important gas discovery in the area was at Ignacio by Stanolind Oil & Gas Company. The first well was completed in the Morrison at 7919 feet. Although the well was not continually cored or completely tested, it apparently had gas in every porous zone from the top of the Cretaceous to within the Morrison. The same company's second well was completed from the Picture Cliff. Although the open flow test on this well was only slightly more than 3 million cubic feet daily, rather careful production tests indicate that the deliverability is much higher than for similar wells in the older San Juan producing areas. From structural evi-



Pennsylvanian reef in Hathaway State Line well 5495-5505, three miles southwest of Dove Creek structure.



Vugular dolomite from Continental Oil Company well near Nucla, Montrose County, Colorado.

Hermosa Bioherm, approximately 40 feet thick. (In the Goosenecks of San Juan Canyon, 4-42s-18e, San Juan County, Utah.)

(Photo Courtesy Sherman A. Wengerd)

dence it is known that this structure is approximately 20 miles long, and the sands are several times thicker than those producing in the older areas. It is generally believed that this is perhaps the largest single sweet gas reserve yet discovered in the area.

As an ultimate stimulus to exploration for oil, the discovery of Continental Oil Company at Table Mesa of 59-gravity sweet oil together with about 12 million cubic feet of non-inflammable gas in the Mississippian is the most important discovery of the past two years. This well is producing 190 barrels daily. It is the first discovery of commercial oil in the Mississippian. The occurrence of non-inflammable gas with oil will undoubtedly cause the re-examination of old prospects that were abandoned on the discovery of such gas in the Paleozoic, such as Dove Creek, McElmo, Tocito, and Montecello.

The drilling of about 600 feet of very porous and vugy dolomite in the Continental's Nucla well and the show of oil in the same zone in The Pure Oil Company's nearby Horsefly well, together with about 1400 feet of, in part, porous dolomites with sand and shales of Ordovician age in the latter well has caused many geologists to believe that these formations may become very important producers of oil in the Paradox Basin and perhaps in the entire Four Corners area, as they have in so many parts of the world. Thinness of the Devonian in outcrops on the uplifts surrounding the basins, together with the failure to show Ordovician in the area on the published Paleogeographic maps, have until recently caused some to discount these periods as potential producing horizons. The Ignacio Quartzite reported in the few deep wells is now generally believed to be some of the thin quartzitic sands frequently found on the outcrop and in the Horsefly well in the Elbert formation of Devonian age and at the top of the Ordovician in that well. Most of the wells in southwestern Colorado and in San Juan County, New Mexico, that have reached the Devonian have shown some porosity, some of it very good with staining. A few tested for large volumes of non-inflammable gas but showed oil staining. The production of a large volume of such gas in Continental's Table Mesa well together with 59-gravity sweet oil, from the Mississippian justifies and will undoubtedly cause further exploration of the Devonian near those old wells.

The Byrd-Frost Western Natural deep well at Boundary Butte finished in 90 feet of Upper Middle Ordovician. This was verified by fossil determina-

tion. It probably did not drill through that formation. Beds probably of Ordovician age in the Elk Ridge and Cedar Mesa wells were only about 200 feet thick. That may represent local thinning on the large Monument uplift rather than regional thinning. Incidentally, these are the only wells drilled, with the exception of some near the rims of the basins and Amerada Petroleum Corporation's Navajo well in northeastern Arizona, that have definitely been drilled to the pre-Cambrian. There is the distinct probability that those wells reported as reaching Ignacio Quartzite may have been completed in the Devonian or the top of the Ordovician, and there may be a good Ordovician section below the total depths.

Tide Water Associated Oil Company's Big Flat well, west of Moab, Utah, drilled about 500 feet of dark dolomites, 285 feet of which had some very good vugular porosity, part stained with a black oil. This has been tentatively identified as Mississippian, but if it is, it is entirely different in appearance from the Mississippian common to the area. It looks more like Pennsylvanian. At any rate, it is a section new to the area. The vugs are suggestive of reefing below the salt. Wells drilled in search of reefing in the Pennsylvanian should look for this zone below the salt.

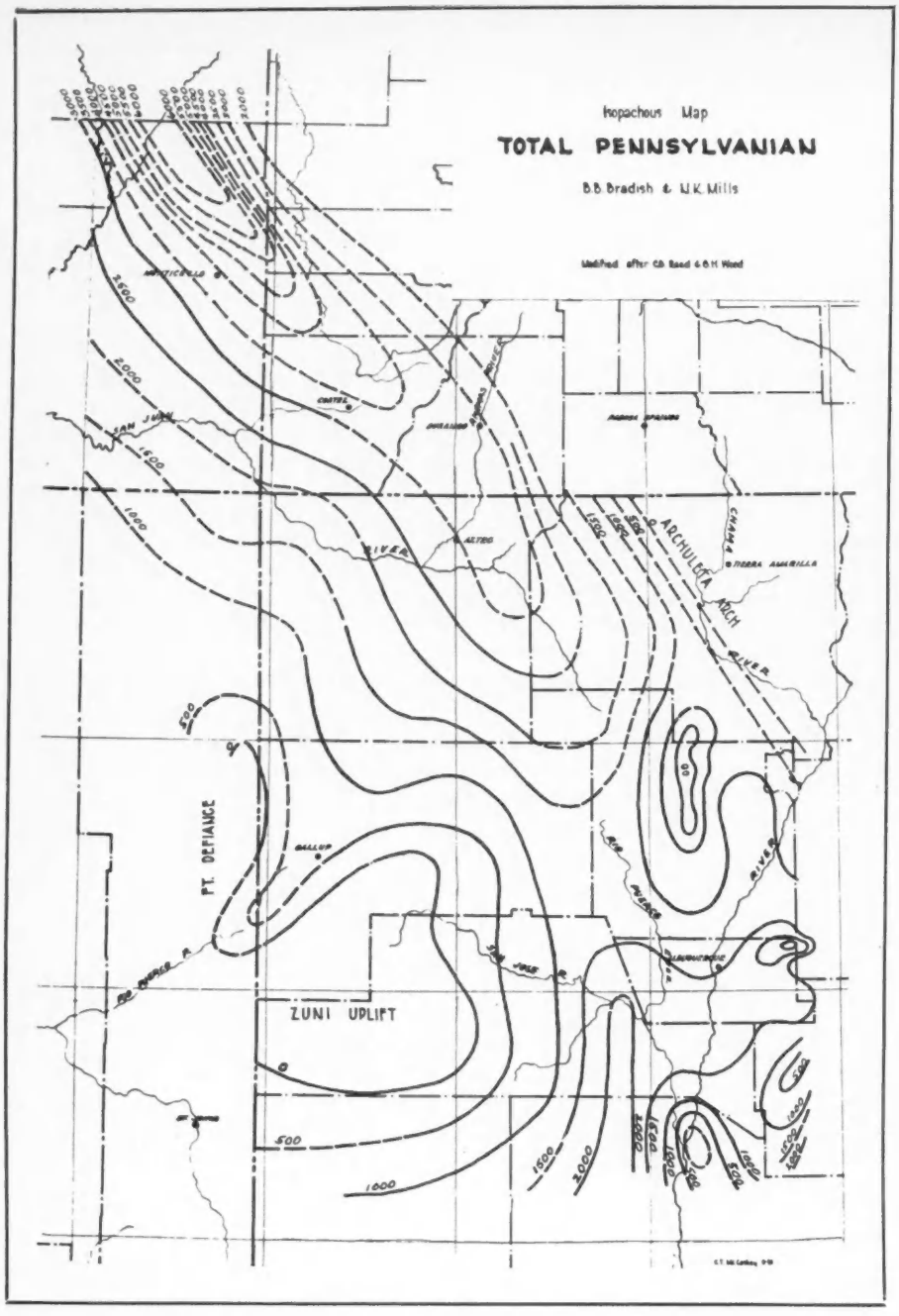
The long, narrow zone in which occur all of the salt anticlines must be a pre-Triassic graben, with one limb against the Uncompaghre and the other near the crest of the Dolores Anticline—Libson Valley Fault—and Big Flat Arch. A deep-seated active graben offers the only satisfactory explanation for the closely packed, relatively steep folds in this zone. That folding was active in this zone during Permian, Triassic, and Jurassic times has been well evidenced by Stokes in his map and report on the Gypsum Valley. Additional recent evidence that this zone was active during Pennsylvanian is the discovery of an angular unconformity within the Hermosa in the Dolores River as it leaves Gypsum Valley, and the occurrence of Hermosa deposits of Benthonic type, i.e. (deposited below the aerated zone) in The Chicago Corporation's Paradox well, and Harry Hubbard's Onion Creek well; in contrast to clean fossiliferous limes of shallow water origin at the above mentioned exposure, at Moab, and in a block floating in the salt in Paradox Valley. Some of these limes contain corals. That at Moab has been determined as of upper Des Moines age (Upper Hermosa). This means the crests of some of these anticlines were high in relation to the flanks during Hermosa (Pennsylvanian) time. Its importance is that the probability of finding reefing or well sorted sands on and near the crests of these salt anticlines, where not removed by the extrusion of the salt, is better than formerly believed.

Since the discovery of Permian oil in West Texas, oil men have associated reefing and oil with salt basins. There was the suggestion of reefing with the porosity destroyed by secondary, gypsum and calcite in the Dove Creek wells. Hathaway Brothers in their State Line well, southwest of Dove Creek, cored ten feet of very vuggy Dolomite, identical in appearance to the reef material of Scurry County, Texas. This was not drilled through. It tested water with some oil on a production test. They have unquestionably found a Pennsylvanian reef with some oil. Its extent and importance is at present unknown. Its importance to future exploration in the area is that it is the first recognized reef material in the Pennsylvanian in a well in the area. Previously, Sherman A. Wengerd had discovered small bioherms in the Hermosa in the canyon of the San Juan at the Goosenecks similar to those described outcropping in the Pennsylvanian on the Bend Arch of Texas. An extensive lease and drilling program will probably be the result of this reef discovery.

Evidence is constantly being found of structural movements during the Paleozoic. The marked contrast in occurrence and thickness of Mississippian and Devonian strata between Pure's Horsefly and Continental's Nucla wells, which are within 12 miles, suggests important movements during those ages. This suggests that the Paradox graben was active as early as Mississippian and by interference that the now salt anticlines may have been initiated at that early pe-

Geologic Sections in Two Key Wells and Comparative Sections in Other Wells in Four Corners Area

Age determination in these two wells by the courtesy of Denver Sample Log Company Denham Bldg., Denver, Colo.		Outcrops and other wells in Four Corners area
Pure's Horsefly Well	**Continental's Nucla Well**	
PERMIAN UNDIVIDED:		
Conglomerate age Questionable 23	Cutler (1) 3763	0–8000 over most of four corners 2000 more or less Non-Marine except Yeso in Southeast and Kaibab and Coconino in west. Greatest known thickness near Uncompaghre.
PENNSYLVANIAN:		
Rico (Penn or Perm) Missing	Missing	0–400 Difficult to pick top or base in wells. Exact age not yet determined, more likely Penn.
Virgil:		
Missing	Missing	Identified as part of Madera Fm in Naciemento Mts. not recognized or missing in wells.
Missouri:		
Missing	Missing	Part of Madera Fm. May be uppermost Hermosa in outcrop and some wells.
Des Moines:		
Missing	Upper part of Paradox Member of Hermosa	Upper portion of Hermosa.
Lampassas:		
Missing	1194′ probably part of Paradox in this well	Entire Penn. 0–6000 plus feet. Thickness unknown in Paradox Basin. See Isopaceous map.
Morrow:		
Missing	Molas 377	0–300 A good marker in most wells over the area.
MISSISSIPPIAN:		
Chester:		
Missing	Missing	Missing
Meramec:		
St. Louis (1) 221	Missing	Leadville undifferentiated
Spergen (1) 150	Missing	0–450
Osage & Kinderhook:		
Missing	Missing	Missing
DEVONIAN:		
Upper:		
Ouray (1) 222	Ouray 636	0–450
Elbert (1) 278	Elbert 286	0–400
Middle:		
Missing	Missing	Missing
Lower:		
Missing	Missing	Missing
SILURIAN—unknown in the area:		
ORDOVICIAN:		
Upper:		
Missing	Missing	Missing
Missing	Missing	Missing
Middle:		
Fremont (?) 1192	Not drilled through	Not known on outcrop, Top logged as Ignacio in many wells. May have been drilled on Monument uplift. 90 feet drilled at Boundry Butte.
CAMBRIAN:		
Cambro-Ord.:		
Harding (?) 268	Not drilled	Missing on outcrop, not drilled.
Manitou (?) 400	Not drilled	Missing on outcrop. Not drilled. Ignacio, Age questionable.
	Not drilled	Missing
Facies questionable 750		Missing or not drilled
Lower:		
Sawatch Equiv. (?) 35 drilled.	Not drilled	Missing, not drilled



riod. More than 1400 feet of Ordovician in the Horsefly well suggests that the thin possible Ordovician of the Monument Uplift may indicate uplift of that feature before or during Ordovician time. Correlations of beds below the salt in other widely spaced wells may be in error. More positive determinations of these may prove more widespread pre-Pennsylvanian folding. The history of Paleozoic folding of the area will eventually furnish a key to the finding of oil in those horizons. More careful search for and determination of fossils in wells already drilled will help in unraveling that history.

Literature on Four Corners Area

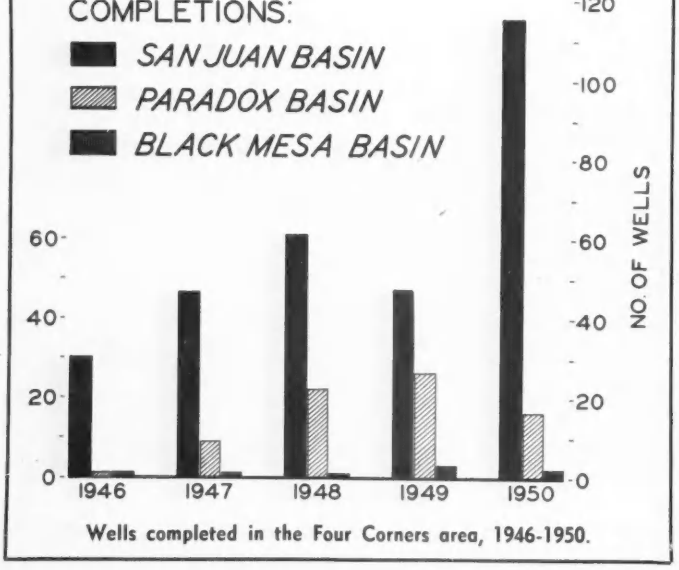
EDITOR'S NOTE.—*For more information on the Four Corners area, see article, "Oil and Gas Exploration in the Four Corners Area of Arizona, Colorado, New Mexico, and Utah," by J. L. Tatum, in* WORLD OIL, *November, 1949, beginning on page 69. That article included a bibliography, discussion of the geology and significant developments of the region, geologic sections, map, and drawings.*

KEY TO MAP

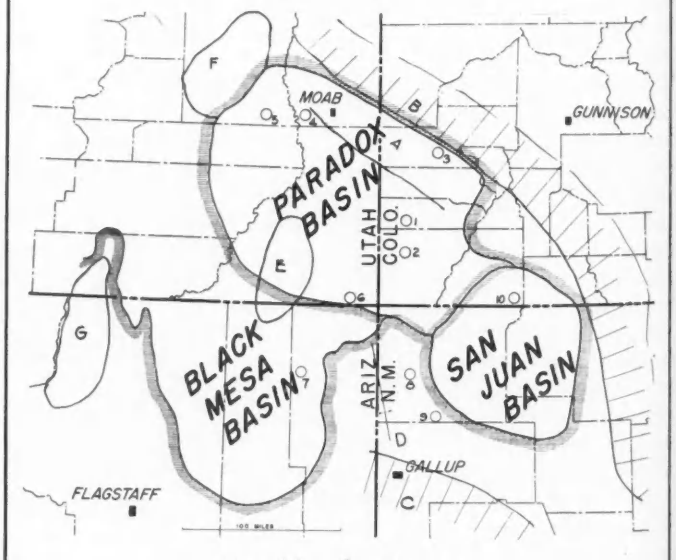
1. Dove Creek
2. Hathaway Brothers State Line well
3. Pure Horsefly and Continental Nucla wells
4. Tide Water Big Flat well
5. General Petroleum San Rafael well
6. Boundary Butte
7. Amerada Black Mesa well
8. Continental Mississippian oil discovery, Table Mesa
9. Southern Union Gas Dakota oil discovery, Stony Butte
10. Stanolind Ignacio gas discovery

STRUCTURAL FEATURES

A. Paradox Graben
B. Uncompaghre-San Louis Highland
C. Zuni Uplift
D. Defiance Arch
E. Monument Valley
F. San Rafael Swell
G. Kaibab Uplift



Wells completed in the Four Corners area, 1946-1950.

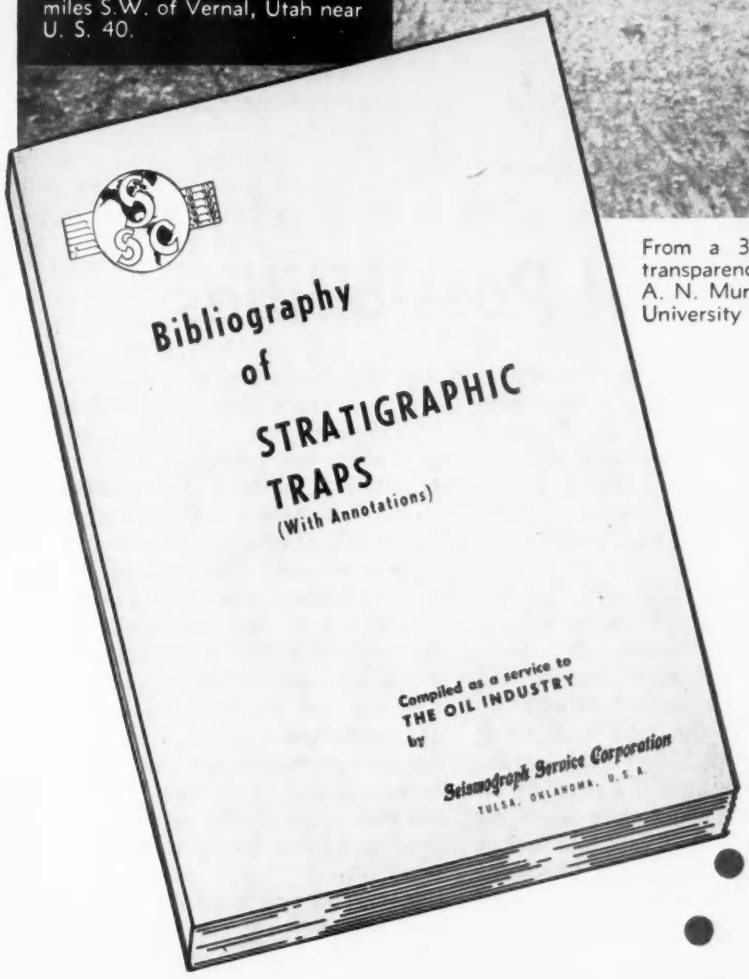


Map of Four Corners area.

Looking For STRAT-TRAPS?..

A channel sandstone in the upper part of Duchesne River formation (Oligocene) about 5 miles S.W. of Vernal, Utah near U. S. 40.

From a 35mm. Kodachrome transparency—Courtesy of Dr. A. N. Murray, Dept. of Geol., University of Tulsa.



THE GEOLOGIST

In view of the increasing importance of Stratigraphic Traps in the search for oil the geologist may wish to review the pertinent literature.

THE GEOPHYSICIST

The geophysicist may wish to reacquaint himself with the various types of Stratigraphic Traps and their possible geophysical expressions.

Seismograph Service Corporation takes great pleasure in announcing the above bibliography. Its gratis distribution is another example of SSC's unexcelled service to the Oil Industry.

Seismograph Service Corporation

Seismic Surveys — Gravity Surveys — Pilot Crews — Lorac

TULSA, OKLAHOMA, U.S.A.

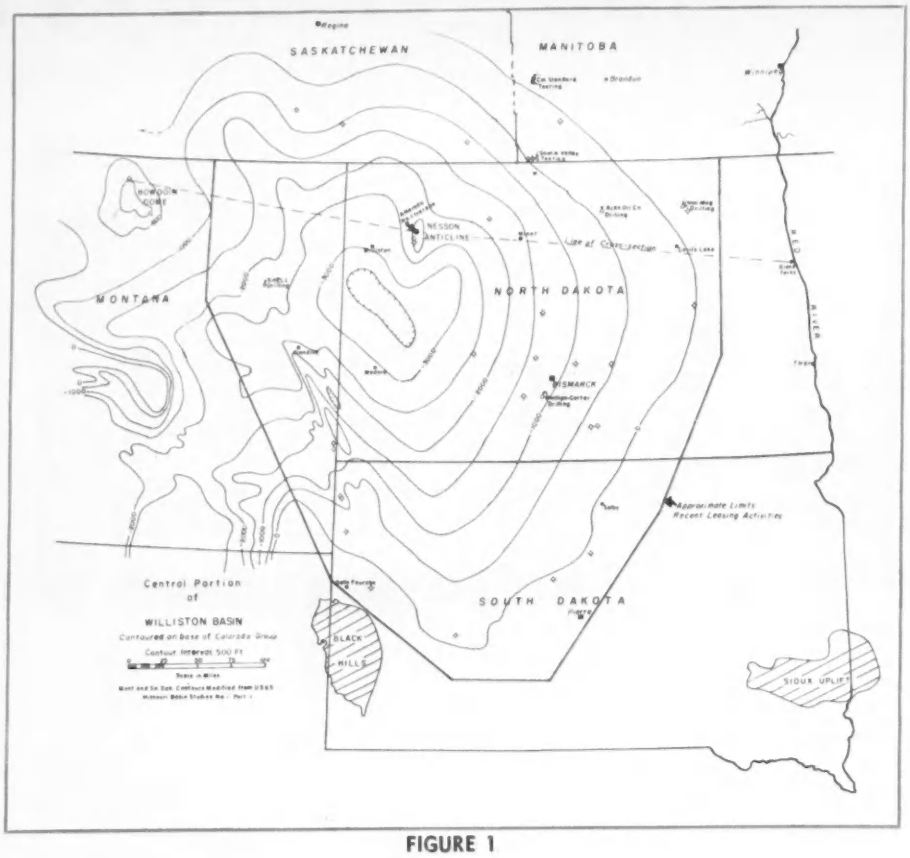


FIGURE 1

THE WILLISTON Basin, vast in area and containing a large volume of sediments of petroliferous character, is potentially one of the world's great producing regions. The Amerada discovery well in North Dakota and two wells in southwestern Manitoba have proved that oil does occur in the basin. Source rocks, reservoir rock, and potential reservoirs of tectonic and erosional origin are present. Intensive exploration is in prospect, and the basin offers possibilities of developing into a major oil province. This article describes the significance of the Amerada oil discovery and of other wells in the region.

By G. WENDELL SMITH
Consulting Geologist
Bismarck, N. D.

Williston Basin Oil Possibilities

ONE of the most significant oil discoveries in recent years is Amerada Petroleum Corporation's Iverson 1 in Williams County, North Dakota. Deep in the heart of one of the world's great sedimentary basins, this well touched off the greatest lease play in terms of volume of acreage in the history of the oil industry. Since April first, an estimated 20 million acres of land in North and South Dakota, Montana, Manitoba and Saskatchewan were leased. An estimated 40 million acres had been leased previous to the discovery. Prices, particularly in the area around the Amerada well, soared daily as acreage became more scarce. Divide, McKenzie, and Williams counties, North Dakota, were the scene of the greatest buying, and at least 90 percent of these counties are now under lease. Great acreages of minerals have also been acquired.

Companies that have acquired the largest holdings include Shell Oil Company, Stanolind Oil & Gas Company, Magnolia Petroleum Company, Union Oil Company of California, Amerada, The Texas Company, Sohio Petroleum Company, Sunray Oil Corporation, Barnsdall Oil Company, The Pure Oil Company, Continental Oil Company, The Carter Oil Company, Phillips Petroleum Company, The California Company, Sun Oil Company, Sinclair Oil & Gas Company, The Atlantic Refining Company, Mid-Continent Petroleum Corporation, The Lion Oil Company, Cities Service Oil Company, Deep Rock Oil Corporation, and H. L. Hunt.

The Iverson 1, SW SW 6-155n-95-w, was located after more than a year's seismic investigation of a large surface structure called the Nesson Anticline (Figure 1) first mapped by A. J. Collier of the USGS in 1918. The first well was drilled on the structure by Big Viking Oil Company in 1935, and was abandoned at 4642 feet as a dry hole. In 1938, subsequent to seismic work of the area, The California Company drilled Kamp 1 in NW NE 3-154n-96w., to 10,281 feet. Shows of questionable value were logged in the bottom 200 feet of this hole, and the hole was lost before adequately tested. It now appears likely that this location may prove productive, although the Amerada production is believed to be from a zone lower than any penetrated in the Kamp well. It is probable that the famous "Pint of Oil" recovery from a drill-stem test in January in the Iverson is from the zone which showed staining in the Kamp. This zone, at 10,452-803, has not been tested through the casing.

The Iverson was deepened below 11,714 feet after flowing an average of 400 barrels per day of 47- to 53-gravity oil with a gas-oil ratio of about 7000 to 1 from perforations at 11630-60. Probably 70 feet of pay zone is present. The producing zone is a limestone and dolomite section considered to be middle Devonian, probably correlative with the Elm Point formation of the Manitoba surface section. Porosity is in the form of small vugs and fractures, but no data on permeability or porosity have been released. There are no definite indications that this is reef production, and most geologists believe that it is not.

Amerada trucked the first production to the Northern Pacific railroad, eight miles north of the well, for transport to the St. Paul refinery of Northwestern Refining Company.

The outstanding fact relative to the Amerada discovery is that it proves oil is present in the sediments in the Williston Basin, rather than that the discovery itself is possessed of any extraordinary productive qualities. The Amerada deep production, plus the 2240-300-foot production discovered in February by Standard Oil Company of California near Verden, 59 miles north of the North Dakota

line, in southwestern Manitoba, has opened up the entire eastern flank of the Williston Basin to intensive study by nearly all oil companies. Many had been previously aware of the area's potentialities, but intensive lease play resulted when exploration men tied the two wells together and realized their significance. The California Company wells are still tight. Guesses at productive horizons are confined to Jurassic, Madison, and Devonian formations. In any case, the productive formation is a carbonate rock and the well is reported pumping from seven to 20 barrels daily. Thus, it is questionable if the two wells so far completed are commercially profitable.

The Amerada, California Company and also the Souris Valley Downey 1 are the wells responsible for the lease rush. The latter, located in lsd. 11, Sec. 9, Twp 1n., R. 27 WPM, in Southern Manitoba, pulled an oil-stained, but very tight core from the top of the Madison in November, 1950, but a fishing job and cold weather shut down the well until May, 1951. It was sidetracked to test shows encountered at 3222-28 feet in the original hole.

Other operations in the Basin shown on Figure 1, include Shell in eastern Montana, northwest of Glendive; the Phillips-Carter test southwest of Bismarck, and the Ajax test northeast of Minot. The Shell test is particularly interesting in that it will be the first deep test on the western flank of the Williston Basin, that will penetrate the older horizons. Another interesting test is in Cavalier County northeast of Devil's Lake, operated by Union and supported by Magnolia. Since Union drilled a "tight" stratigraphic test near this location, the seismic work should be based on good geological data. Should this well hit, seismic investigations of the shallower east flank of the basin would be proved highly effective, and thus the region of investigation may shift to the shallower parts of the basin.

Exploration in the Dakotas and Montana has been carried on by several companies for the past two years. Shell probably leads in crew-weeks of seismic exploration, with California Company, Stanolind, Phillips, Continental, Pure, Carter, Amerada and Union all being quite active during the summer months of the last two years. Several gravity and magnetometer crews have worked North Dakota. A few independents have worked local areas by seismograph. Surface geology has been done by most of the majors in various areas of the Dakotas and eastern Montana, although the majority of this work

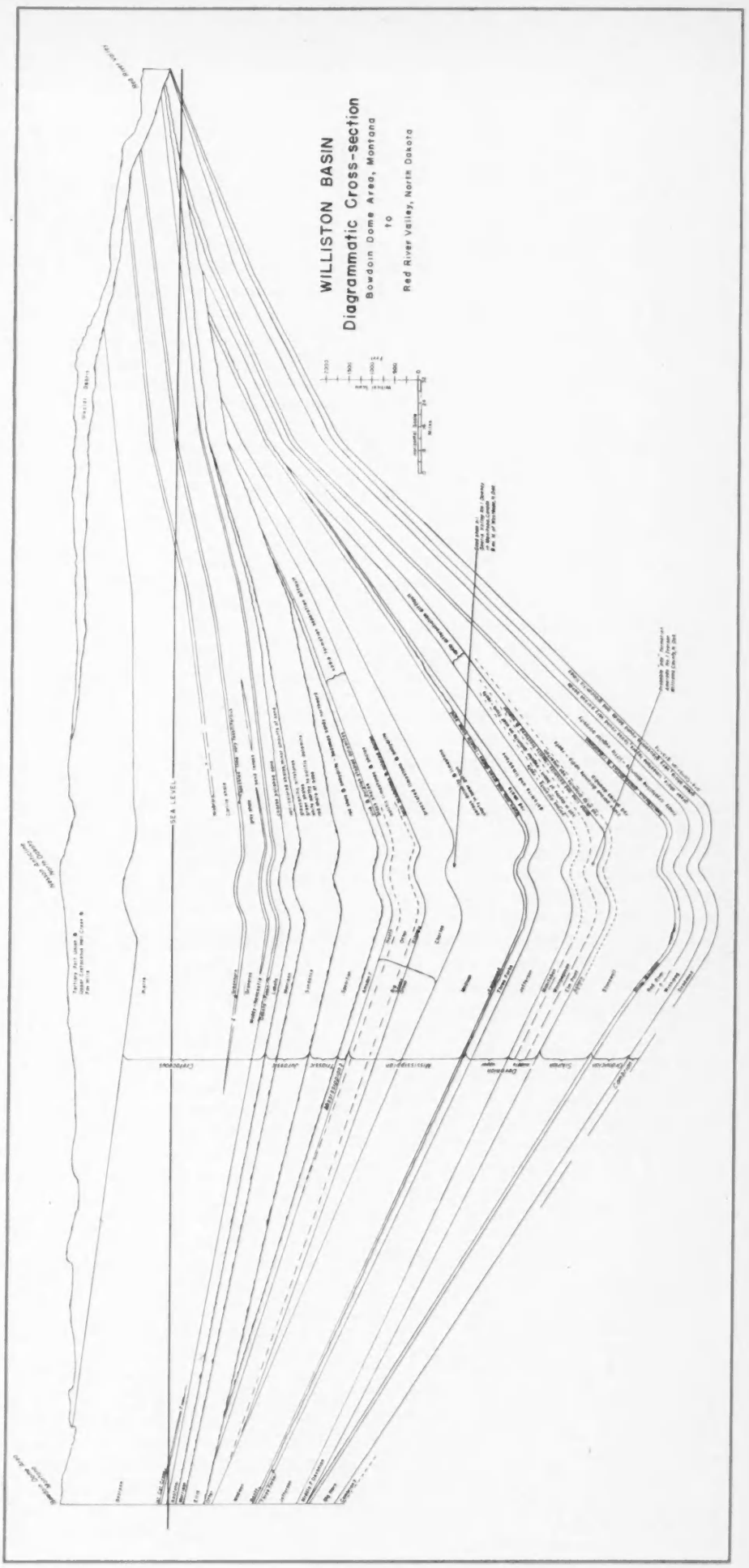


FIGURE 2

was done in the early 1940's before World War II brought an end to the first play in the basin.

Cities in North Dakota with permanent oil company offices include: Bismarck, where Magnolia has land and geological offices, and Shell, Sinclair and Phillips have land offices, and Pure has geological offices; Devil's Lake, where Union has land and geological offices; and Williston, where Amerada has land and geological offices. Most brokers, and major company buyers headquarter in Bismarck, with some in Minot.

The Williston Basin, and its Canadian continuation, contain a sufficient volume of sediments of petroliferous character to make this one of the world's potentially great producing regions. Details of the stratigraphy are yet to be worked out, (see Figure 2 for generalized section) but it appears that possible source beds include the Colorado shales, the marine Jurassic, the highly bituminous brown shales of the Englewood (correlative with the Kansas-Oklahoma Woodford), as well as the entire marine sections of the Mississippian, Devonian, Silurian, and Ordovician sediments. These underlie the western three-fourths of North Dakota, the northwest and central parts of South Dakota, as well as the eastern third of Montana, the southwestern corner of Manitoba, and all of Southern Saskatchewan, at the western border of which they blend with the Alberta sediments, whose productive character have been proven. In addition, western South Dakota and southwestern North Dakota are underlain by Pennsylvanian and Permian marine sections whose Wyoming correlatives are highly oil productive.

Possible oil structures are the obvious Nesson Anticline and its southward continuation, the Keene Dome, and the Baker-Glendive structure, with inadequate productive history from the Paleozoic, plus other known seismic structures of much less closure. Since most of North and South Dakota east of the Missouri River is blanketed by glacial debris ranging up to 500 feet thick, the seismograph is need to find the closures. However, from an independent oil company's viewpoint, shallow tests between 2500 and 5000 feet in depth along the basin's east flank are attractive in that the Newcastle-Muddy and the Dakota sands are of known lenticular character, and pinch out locally, much as they do on the western flanks of the Black Hills in Wyoming. Further, the Paleozoic sediments of known phenomenal porosity are either truncated or pinchout along the east and south flanks of the Basin, and as previously pointed out, the Pennsylvanian and Permian sediments pinch out between the Baker-Glendive anticline and the Nesson Anticline. These pinchouts and truncations should prove attractive to smaller operators. There are unconformities of potential oil-trapping qualities at the base of the Muddy, the base of the Lakota, base of the Morrison, Sundance, and Spearfish. Also unconformable is the Englewood-Devonian contact.

Going down the section (see cross-section, Figure 2) in terms of reservoir potentialities, the Muddy and Dakota are first encountered. These formations are good aquifers on the east and south flanks at shallow depths, but their lenticularity and locally good porosity should also make them good oil reservoirs at relatively shallow depths. The Morrison is not highly regarded as a potential reservoir, but the Sundance sands and siltstones have good porosity. The Amsden is of varying lithology, and this fact should make for pinchout production. The porous Kibbey sands also pinch out irregularly. Staining has been found in Charles and Madison limestones and dolomites, and the Madison has excellent porosity in its upper portions. Some geologists also claim reef origin for part of the Madison section. The entire Devonian section is probably the best of the likely oil-containers. It is marked by vugular and inter-crystalline and granular porosity and known reef character. Manitoba outcrops of the middle Devonian contain bioherms. Some of the porosity is of the highest order, particularly the vugular. The Silurian Stonewall dolomite is excellently crystallized and in some wells has been reefoid in character. It is probably filled with small bioherms on the surface in Manitoba where the immediately overlying middle Devonian sediments are arched and broken as if draped over a reef. It has excellent porosity in the North Dakota subsurface.

The Winnipeg sandstone, particularly in south-central North Dakota, has an appearance so similar to the Bromide sands of Oklahoma and Kansas as to be practically indistinguishable. In addition, it has practically no cementation of its spherical pitted sand grains, with consequent high porosity and excellent permeability. It is known to disappear by pinchout or erosion along the east flank of the basin. A truncated wedge of this highly permeable formation of Ordovician age could well prove highly productive.

In summary, the Amerada, California Standard, and Souris Valley wells have proved that oil does occur in the thick volume of sediments in the huge Williston Basin. Source rocks, reservoir rock, and potential reservoirs of tectonic and erosional origin are present. There are about 60 million acres under lease. An intensive exploration of the prairie northwest may well develop a new and major oil province for the country.

About the Author

G. WENDELL SMITH, a native of Colorado, received his bachelor's degree in geology at the University of Colorado in 1940, and his master's from Michigan State in 1942. After three years in Oklahoma, during which time he worked largely in the southern part of the state for Magnolia Petroleum Company, he was transferred to San Antonio. His four years in San Antonio were devoted to exploration geology of both surface and subsurface along the Luling fault zone. In the spring of 1949 Magnolia transferred him to Bismarck, N. Dak., where he worked until April of this year, when he resigned to become a consulting geologist with the firm of Smith and Curran with offices in Bismarck. Smith has studied the surface exposures of the Black Hills and the Manitoba surface outcrops, as well as the wells of the central part of the Williston Basin. He is a member of AAPG and Sigma Xi.

BIBLIOGRAPHY

NORTH DAKOTA

[1] Bull. Am. Assoc. Pet. Geol., Vol. 27, No. 12, "Tertiary Geology and Oil and Gas Prospects in Dakota Basin; North Dakota," by Ray V. Hennen, 1943.

[2] Op. cit., Vol. 26. No. 10, "Regional Geology of Dakota Basin," by Norval Ballard, 1942.

[3] N. Dak. Geol. Surv., Bull. 12, "Selected Deep Well Records," compiled by W. M. Laird, 1941.

[4] N. Dak. Geol. Surv., Bull. 21, Pt. I, "The Keene Dome, Northeast McKenzie Co., N. Dak." by Chas. Nevin; Pt. II, "The Sub-Surface Stratigraphy of the Nesson Anticline," by W. M. Laird. 1946.

[5] U.S.G.S. Bull. 691-G., "The Nesson Anticline; Williams Co., N. Dak.," 1918.

SOUTH DAKOTA

[1] South Dakota Geol. Surv., Rept. Inv. #4, "Logs of Some Deep Wells in Western South Dakota," 1946.

[2] South Dakota Geol. Surv., Rept. Inv. #57, "Deep Borings of Western South Dakota," 1947.

[3] So. Dak. Geol. Surv. Rept. Inv. #61, "Additional Well Borings in South Dakota," 1948.

[4] So. Dak. Geol. Surv. Rept. Inv. #67, "Well Borings in So. Dak., 1948-1950." 1951.

MONTANA

[1] Op. cit., Vol. 34, No. 3, "Paleozoic Sedimentation in Montana Area," by L. L. Sloss, 1950.

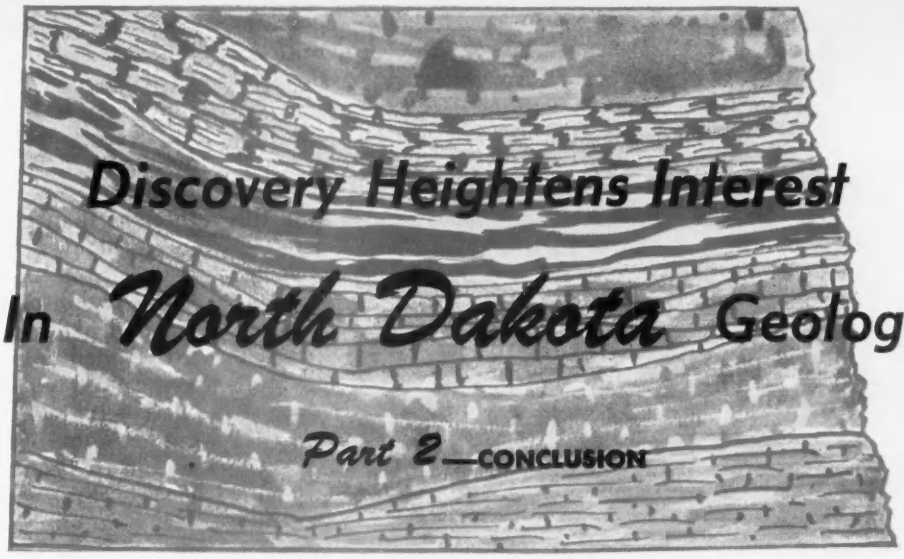
SASKATCHEWAN

[1] Mineral Resources Branch, Dept. of Nat. Resources, Province of Saskatchewan, Part I, Schedule of Wells Drilled for Oil and Gas to 1950," Part II, "Exploration, Drilling, and Production Data to 1950," Regina: 1950.

MANITOBA

[1] Mines Branch, Manitoba Dept. of Mines and National Resources, Publ. 49-1, "The Stratigraphy of Manitoba with Reference to Oil and Natural Gas Possibilities." Winnipeg, 1949, and Supplement, to Jan. 31, 1951, "Schedule of Wells."

[2] Op. cit., Publ. 49-2, "Devonia Geology of Lake Manitoba—Lake Winnipeg osis Area," Winnipeg, 1950.



Discovery Heightens Interest In North Dakota Geology

Part 2—CONCLUSION

By DR. WILSON M. LAIRD

State Geologist, North Dakota Geological Survey, University of North Dakota, Grand Forks

CONCLUDING a discussion of oil possibilities in North Dakota, the author evaluates the Permian, Triassic, Jurassic, Cretaceous, The Cannonball-Ludlow and Pleistocene. He concludes that best prospects for oil and gas production are in Devonian beds, where abundant porosity has been found. Second in importance, he believes, are Mississippian beds, notably the upper part of the Madison formation.

PERMIAN: The Permian is also poorly represented in North Dakota. It is known largely from the Carter N. P. 1 well in Fallon County, Montana. There it consists of two formations. The Opeche formation is found at the base of the Permian and in the well mentioned it is 88 feet thick. The lithology consists of red shale and anhydrite. It is overlain by the Minnekahta formation which in the Carter well is 40 feet thick. This formation consists of purple dolomite and limestones.

TRIASSIC: The Triassic is represented by the Spearfish formation which consists rather largely of reddish, medium-to-fine-grain sandstones, and some red and gray silty shale. Some gray and black shales and anhydrites are also present. The thickness of the formation varies from 30 to 895 feet. There is some question as to the extension of the Spearfish this far from its type area in the northern part of the Black Hills. The difficulty is that the lithology of the Spearfish is very similar to parts of the lithology of the basal part of the Big Snowy group and also to the basal part of the overlying Jurassic. They might easily be misidentified if the upper part of the Big Snowy were missing.

JURASSIC: The Jurassic in North Dakota is represented by the Morrison formation and by what is frequently called the Sundance formation. The writer would prefer to call this the Ellis group. The Ellis group in Montana has been subdivided into three formations—the Sawtooth or Piper, the Rierdon, and the Swift, starting from the base upward. The Sawtooth is the thickest of the three and consists rather largely of evaporitic sequence which includes limestones, anhydrites, and some shale. At the top of the Sawtooth or the base of the Rierdon is an oolitic limestone or microconglomerate which is quite consistent, making it an excellent marker bed. It is overlain by the Rierdon, largely a black and gray shale sequence with some oolitic and dense limestones. The Rierdon is overlain by the Swift formation which consists of glauconitic sandstones and some gray-green shale. The Swift is of some interest from the standpoint of oil development as it might provide a suitable reservoir rock. However, as the formation is traced eastward from its outcrop in Montana, it becomes increasingly more shaly with the result that it is very difficult in the subsurface to distinguish it from the underlying Rierdon. The total thickness of the Sundance or Ellis formation varies from 90 to 895 feet.

Overlying the Sundance or Ellis formation is the Morrison formation which consists of gray, green, and variegated shales and shaly sandstones. It varies from 0 to 260 feet in thickness in North Dakota. It is difficult to distinguish in the subsurface, but usually is identified as a shale interval present between the upper part of the Ellis on one hand and the basal part of the Dakota group on the other.

CRETACEOUS: The Cretaceous is inaugurated by a group of sandstones and shales which have been called collectively the Dakota group. A recent author,[4] however, would term this group the Inyan Kara and would discard the term Dakota altogether apparently. His terminology would be, starting from the base, Dakota sandstone, Fuson shale, and Fall River standstone. It would appear that the formation herein called the Dakota sandstone formation would probably be correlative with his Fall River sandstone. He places the whole group plus part of the overlying sequence which is called herein the Banton formation, in the lower Cretaceous. Sufficient study of North Dakota Cretaceous stratigraphy has not been made as yet to pass an opinion as to the exact age of these formations. It would appear, however, that the Dakota sea was a transgressing one and therefore the formations in North Dakota might be

somewhat younger than those present in the type area in South Dakota.

The Dakota group consists of a series of clean white to dirty gray sandstones and interbedded gray shale. It is difficult if not impossible in some wells to distinguish the three formations shown in Table 1. The Dakota is famous for the amount of artesian water it produces. Some small amounts of gas associated with water have been found in the southeastern part of North Dakota. An approximate correlative of the Dakota group, the Viking sand in Alberta and Saskatchewan, does produce some oil. It might conceivably produce some in North Dakota although little encouragement for this can be given.

Above the Dakota but separated from it by a shale interval, is a sand and shale sequence tentatively being correlated with the Muddy sand. It varies from 0 to perhaps 90 feet in thickness. It lenses out rapidly eastward from the center of the basin and quite possibly could contain oil. It deserves more consideration and thought than has thus far been given it, especially as it is relatively shallow.

TABLE I
Geologic Formations in North Dakota

CENOZOIC	Olig.					White River formation 50–200′ clays, shales, limestone, sandstone.
	Eocene	Wasatch Stage				Golden Valley formation 100–200′ light-colored clay, ash, sandstone.
	Paleocene	Fort Union Stage				Tongue River formation 200–800′ light-colored and dark-colored calcareous shale and sandstone and lignite.
						Cannonball-Ludlow formation 0–360′ marine sands, clays, Ludlow 0–250′ lignite, shale and sandstone.
MESOZOIC	Cretaceous	Upper				Hell Creek formation 100–575′ grey bentonitic sandstone and shale, lignitic shale and concretions.
			Montana Stage			Fox Hills 180–320′ brown to grey sandstone with ironstone concretions.
						Pierre formation 930–2300′ grey shales and ironstone concretions.
			Colorado Stage			Niobrara formation 80–100′ grey shale and "cement rock."
						Benton formation 90–1360′ dark grey shale.
						Dakota formation 10–300′ micaceous white sandstone with pyrite, gypsum and lignite.
		Lower				Fuson formation 50–150′ grey shale, sandy shale and sandstone.
						Lakota formation 20–190′ white sandstone with little shale.
	Jurassic					Morrison formation 0–260′ grey and green shale and shaly sandstone.
						Sundance formation 90–895′ glauconitic sandstone, green shale, sandstone and shaly limestone with gypsum.
	Tria.					Spearfish formation 30–895′ red sandstone and red shale, brown sandstone, red shale and red evaporites.
PALEOZOIC	Permian					Minnekahta formation 40′ purple dolomite and limestone. Not extensively developed in the state.
						Opeche formation 88′ red shale and anhydrite. Not extensively developed in the state.
	Pa.					Minnelusa formation 0–200′ white and reddish sandstone. Not extensively developed in the state.
	Mississippian	Tennessean	Meremac-Chester	Big Snowy Group		Amsden formation 0–250′ orange, red, purple dolomite limestone shale.
						Heath formation 0–335′ black carbonaceous shale, grey to green shale, dolomite.
						Otter formation 0–100′ varicolored shale and anhydrite.
						Kibbey formation 60–300′ varicolored shale and fine grey sandstone near base.
						Charles formation 50–890′ brown buff dolomite limestone, grey and white anhydrite, varicolored shale.
		Waverlyan	Osage	Madison Group		Mission Canyon formation 80–530′ granular and oolitic buff limestone.
						Lodgepole formation 75–880′ grey to buff granular to finely crystalline limestone.
			Kinderhook			Englewood formation 25–110′ carbonaceous shale, limestone, grey shale and siltstone.
	Devonian					Lyleton formation 0–190′ calcareous red shale.
						Manitoban formation 0–250′ granular buff limestone, dolomite and anhydrite.
						Winnipegosan formation 0–660′ granular and dense grey to brown limestone and dolomite.
						Elm Point 0–60′.
						Ashern 0–117′.
	Silurian system 0–150′.					
	Ordovician					Stony Mountain formation 100–500′ dense to granular buff to white dolomitic limestone and varicolored shale.
						Red River formation 100–600′ grey to tan dense to granular dolomitic and sandy limestone.
						Winnipeg formation 100–535′ green shale, conglomeratic sandstone.
	Cambrian 60–220′ green shale, and dolomite, glauconitic sandstone.					
	Pre-Cambrian granite and amphibolite.					

Overlying the Dakota group is a large section of Cretaceous shales. In North Dakota in general these shales are divided only into the larger headings, notably the Benton, Niobrara, and Pierre. The Benton formation is from 90 to 1360 feet thick and consists rather largely of a dark gray, usually non-calcareous shale. It is in turn overlain by the Niobrara formation varying in thickness from 80 to 800 feet of rather largely gray shale with "cement" rock, a very calcareous shale, at the top. At the top also are a number of fossils, notably the "Globigerina." These zones containing the Globigerina are sometimes called the white speckled zones and there seem to be several in the Niobrara. Just exactly whether or not these can be used as marker beds is not known at present.

The Pierre formation overlies the Niobrara and is from 930 to 2300 feet thick. This is largely an extensive gray shale sequence. At the base on the outcrop of the northeastern corner of North Dakota is a bed of the so-called "Fuller's earth" which appears to be a badly leached bentonitic shale. Whether or not this can be found in the subsurface is doubtful. In any event, it is a good marker at the surface.

Overlying the Pierre is the Fox Hills formation. This is the last great Cretaceous marine incursion into North Dakota. It consists rather largely of gray glauconitic sandstone and interbedded greenish-gray marine shale and varies in thickness from 180 to 320 feet. It outcrops in the central part of the state along the Missouri River and its tributaries not too far distant from the South Dakota border. It is also found at the surface in the southwestern corner of the state in Bowman County.

The uppermost Cretaceous formation is the Hell Creek. This is largely a continental formation consisting of fine-grained, argillaceous sandstone, lignitic shales, and some thin lignites. It is approximately 100 to 575 feet thick and contains at its base a small, thin marine bed which is fossiliferous. This member has been called the Brien sandstone for a town of that name in the southern part of Morton County, North Dakota. The Hell Creek formation is characterized by non-marine fossils, notably the re-

January 18, 1907 OIL INVESTOR'S JOURNAL

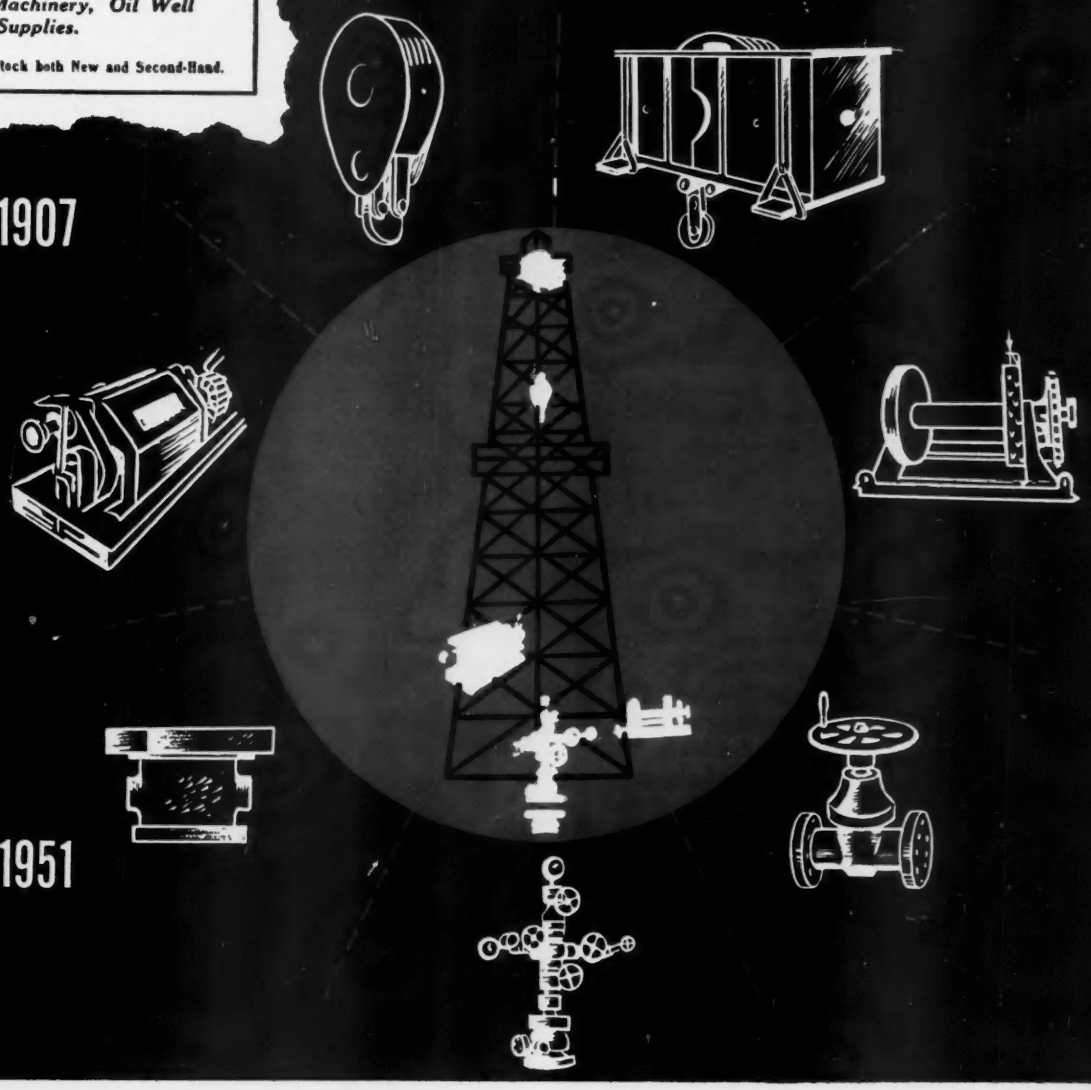
BEAUMONT IRON WORKS, INC.

BEAUMONT, TEXAS

Manufacturers of Complete Rotary Drilling Rigs. Standard Rig Irons, Oil Well Machinery, Oil Well and Pipe Line Supplies.

We carry Boilers, Engines and Pumps in Stock both New and Second-Hand.

PRODUCING IN 1907



...PRODUCING IN 1951

BIW Rotary Drilling & Production Equipment *for fast, low-cost operation*

Today—enriched by nearly a half century of experience—BIW continues to produce a wide variety of equipment including drawworks, crown and traveling blocks, wellhead assemblies, coring reels and other equipment of high quality design and fabrication.

A specialty product is the Atlas-Hughes non-lubricated valve for Christmas tree and other oilfield uses. For information on all BIW drilling and production equipment, get in touch with your nearest Atlas Engineering Works representative.

exclusive sales agents

ATLAS ENGINEERING WORKS

Houston and Beaumont, Texas

BEAUMONT

IRON WORKS COMPANY

Subsidiary, American Locomotive Company

mains of the dinosaur Triceratops.

TERTIARY: The Cannonball-Ludlow formations represent a transitional marine-non-marine sequence. From the Missouri River west for about 50 miles, the Cannonball formation is found well developed. It consists of fossiliferous marine sands interbedded with green-gray to black marine shales. It intergrades with the Ludlow formation which takes its place as the Cannonball disappears westward. The westernmost extent noted of the Cannonball is on the Little Missouri in Slope County. The Ludlow averages from 0 to 250 feet in thickness and is entirely a non-marine sequence consisting largely of lignite, shales, and sandstones.

Overlying the Cannonball-Ludlow is the Tongue River formation, averaging 200 to 800 feet in thickness. The top is seldom seen in view of the fact that a considerable erosional disconformity is found at its top. This formation consists of light- and dark-colored calcareous shales and sandstones and lignite. This formation is the main lignite-bearing formation of North Dakota.

The Tongue River is overlain by the Golden Valley, which varies from 100 to 200 feet in thickness. This consists of a light-colored clay, ash, and sandstone sequence in which the sands are fine-grained and micaceous. The amounts of clays and shales are minor, but in the basal part of the formation there is a sequence of hard, white to dark gray clays and local lignites which are frequently mottled with yellow upon weathering. This makes the bed an excellent barker bed where it is exposed.

Overlying the Golden Valley formation of Eocene age is the White River formation of Oligocene age. This consists of an erratic-occurring formation from 50 to 200 feet in thickness of shales, clays, limestones, and sandstones. It caps only the higher buttes of the state, and is known from very local occurrences in the southwestern corner of North Dakota. It is not extensive and apparently represents river and local lake deposits in the latest part of the Cenozoic.

PLEISTOCENE: Most of the eastern and northern part of the state is overlain by a sequence of glacial materials largely of Wisconsin age. These formations are not of interest from the standpoint of oil geology except for the fact that they mask the beds which immediately underlie them. They also tend to make seismic prospecting somewhat difficult.

Oil and Gas Possibilities

It is the opinion of the writer that the best possibilities at present for oil and gas production lie in the beds of the Devonian. These beds of either Upper or Middle Devonian age apparently have abundant porosity, and the fact that they have produced oil, particularly in Alberta, makes them especially interesting.

Second in importance are those of the Mississippian beds, which contain a number of horizons which might produce. The most favorable of these from the standpoint of porosity is apparently the upper part of the Madison formation. Oil has been found in it in Souris Valley Petroleum Company's Downey 1 and there have been numerous shows in other wells. The Downey well recently was reported drilling at 4137 feet. At mid-April, some weeks after completion as a discovery well, Standard Oil Company of California's Daly 15-18 in Lsd 15, Sec. 18 twp., 10 n., r 27 w., p.m., near Virden, Manitoba, was pumping 7 barrels per day of 33 gravity dark brown oil and 16 barrels per day of water from a depth of 2200 to 2340 feet in beds which apparently are Madison equivalents.

Overlying the Madison is the Charles formation, which also has abundant porosity in its limestone. No oil has been found in this, but occasional oil stains have been noted.

Overlying the Charles is the Kibbey, a shale and standstone sequence, which might have sufficient porosity to produce oil. However, none has been noted in this formation in North Dakota. At the upper part of the Big Snowy group is the Heath formation. This formation is largely shale, but occasionally sand stringers are found which in Montana have produced oil.

From the standpoint of secondary importance, the beds of the Ordovician offer a great deal from the standpoint of potential oil producers. Notably, attention should be called to the very porous zone in the upper part of the Red River formation. This zone has abundant porosity and should oil occur there, the wells should be large producers. In the basal part of the Ordovician in the Winnipeg sand section, excellent porosity has been noted in certain of the wells in the state, notably the Northern Ordinance Franklin Investment 1.

The Silurian is not extensively known in the state. As has been mentioned, however, it has biostromal lenses in the outcrop in Manitoba, and if such beds are found in the subsurface in North Dakota, they should certainly afford abundant porosity for the occurrence of oil.

The Dakota sandstone in North Dakota has been notable for its lack of petroleum. It has, however, produced in a number of other states, notably Wyoming, Montana, and as the Viking sands in Alberta and Saskatchewan. In North Dakota, however, it is abundantly supplied with water and so to date it has not given any indication that it would be an oil producer. However, in some of the old water wells in the southeastern part of the state, considerable amounts of gas have been encountered in this horizon.

The Muddy sand in the central and east-central part of North Dakota also shows significant porosity, which with its shallow depth should make it of interest.

The sands of the upper part of the Jurassic also might have some potential reservoir rock. However, these sands are erratic and do not appear to be too favorable from the standpoint of potential oil and gas horizons. The basal part of the Jurassic where numerous oolitic limestones are present might have some possibility as a potential oil producer.

About the Author

DR. WILSON M. LAIRD, state geologist of North Dakota, graduated from Muskingum College with a B.A. degree in 1936. He obtained his Master's degree from the University of North Carolina in 1938 and his Ph.D. from the University of Cincinnati in 1942. He was assistant professor of geology, University of North Dakota in 1940-42; associate professor in 1942-46; and was appointed state geologist in 1941 and professor in 1946. He also served on field and survey sessions for the Pennsylvania Geological Survey and the U. S. Geological Survey and has acted as consultant for various oil companies since 1948. In 1950 he was elected president of the Association of American State Geologists.

REFERENCES

[4] Crowley, A. J., "Possible Lower Cretaceous Uplifting of Black Hills, Wyoming, and South Dakota," Amer. Assoc. of Petroleum Geologists Bull., Vol. 35, pp. 83-107, 1951.

Tuffy® ROTARY LINES

...Make Any Good Rig BETTER!

Wherever you go in the oil fields, you'll find that the drillers who get the most out of their rigs are the drillers who depend on TUFFY Rotary Lines.

TUFFY Rotary Lines are made with special steels and employ a unique construction that give them extra resistance to shock loads, crushing on drums and internal friction. That's why TUFFY Lines give you more round trips under all conditions.

DRILLERS! Send for this Ton-Mile Indicator

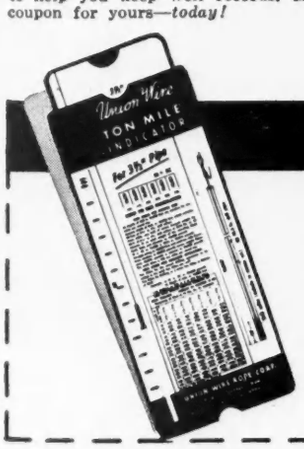
Union Engineers have developed this easy-to-use tool to help you measure the amount of work your rotary line has done. It helps you establish the proper time for cutting off. No complicated figuring with this Ton-Mile Indicator. It does all the work. With it you get a Union Log Book to help you keep well records. Mail the coupon for yours—*today!*

TUFFY Standard Rotary Line

Designed for use on standard rigs and recommended for jackknife rigs when drilling deep.

TUFFY Jackknife Rotary Line

Spools and reeves easier at high speeds over the smaller drums of the jackknife rig.



union Wire Rope **corporation**

EASY TO ORDER

Just specify the type of TUFFY Rotary Line you need—Standard or Jackknife—the length of line and the size. That's all. No complicated ordering symbols. It's easy.

2104 Manchester Ave., Kansas City 3, Mo.

Gentlemen: Please Have Your Fieldman Deliver My Union Ton-Mile Indicator and New Log Book and Show Me How Easy It Is To Use.

NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Exploration

Sets All-Time Record

NINE hundred and two exploratory wells were completed during May to set an all-time high mark for a single month. Partly as a result of that record-breaking activity, total tests completed in the first five months of this year were 19 percent more numerous than those drilled in the comparable period of 1950.

Of the month's 902 wells, 168 were rated commercial producers, and they amounted to 18.6 percent of the total. Among the successful ventures were 116 wells that found new oil sources. New oil fields were opened by 89 tests, and 27 others located new oil strata in previously discovered fields.

Twelve new distillate pools were opened—eight new fields and four new distillate pays. Gas discoveries numbered 14, and all but one were newly opened areas.

During the first five months, 3789 exploratory tests were completed, and compared with the 3183 drilled a year earlier they represented an increase of 19 percent. However, oil discoveries bettered that gain by increasing 24.9 percent. Natural gas discoveries were also above the over-all hike by gaining 26.8 percent.

Summary of Results of Exploratory Drilling

ITEM	May, 1951	April, 1951	FIVE MONTHS January-May 1951	1950	Percent Diff.
Oil Discoveries	116	114	507	406	+ 24.9
New Fields	89	83	360	295	+ 22.0
New Pays	27	31	147	111	+ 32.4
Distillate Discoveries	12	6	35	31	+ 12.9
New Fields	8	5	25	27	— 7.4
New Pays	4	1	10	4	+150.0
Gas Discoveries	14	12	71	56	+ 26.8
New Fields	13	7	54	50	+ 8.0
New Pays	1	5	17	6	+183.3
Total Discoveries	142	132	613	493	+ 24.3
Extensions to Fields	26	31	119	127	— 6.3
Oil Fields	18	23	85	112	— 24.1
Distillate Fields	1	2	10	4	+150.0
Gas Fields	7	6	24	11	+118.2
Total Prod. Tests	168	163	732	620	+ 18.1
Dry Holes	734	644	3,057	2,563	+ 19.3
Wildcats	704	605	2,879	2,459	+ 17.1
New Pays	1	.....	5	5	.....
Outposts	29	39	173	99	+ 74.7
Total Expl'tory Tests	902	807	3,789	3,183	+ 19.0
Percent Productive	18.6	20.2	19.3	19.5	.....
Percent Dry	81.4	79.8	80.7	80.5	.....

Results of Exploratory Drilling in May and First 5 Months, 1951-1950 by Districts

State or District	MONTH OF MAY, 1951													FIRST FIVE MONTHS, 1951																
	Productive Tests									Total Productive	Unproductive Tests			Total Exploratory Tests	Productive Tests								Total Productive		Unproductive Tests				Total Exploratory Tests	
	New Fields			New Pays			Extensions				Wildcats	New Pays	Outposts		New Fields			New Pays			Extensions						Total Dry			
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas						Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	5 Mo. 1951	5 Mo. 1950	Wildcats	New Pays	Outposts	5 Mo. 1951	5 Mo. 1950	5 Mo. 1951	5 Mo. 1950
Alabama											2			2				1			1			2	1	8			8	8	10	9
Arizona																										2			2		2	
Arkansas				1			1			2	7			9	3			5			2			10	5	27		4	31	34	41	39
California	3			1					1	5	31		2	38	8		1	5			4		1	19	20	183	2	20	205	151	224	171
Colorado											8			8	1					1				2		35		1	36	14	38	14
Florida																										1			1	5	1	5
Georgia																													3		3	
Idaho																										1			1	3	1	3
Illinois	4			1			5			10	66			76	9			8			11			28	40	191			191	249	219	289
Indiana	1									1	38			39	10			3						13	15	126			126	165	139	180
Kansas	15		2	3						20	86			106	61		4	14						79	42	302			302	229	381	271
Kentucky	1			3			2			6	22			28	3			5			5			13	3	56			56	16	69	19
Louisiana	5	1		1	1		1	1		10	26			36	15	1	1	11	2	2	7	1		40	39	107		9	116	81	156	120
North Louisiana	4						1	1		6	19			25	8			2	1	2	4	1		18	11	65		2	67	34	85	45
South Louisiana	1	1		1	1					4	7			11	7	1	1	9	1		3			22	28	42		7	49	47	71	75
Maryland																													1		1	
Michigan				1						1	27			28	4		2	1		1				8	19	111			111	105	119	124
Mississippi	3									3	14			17	4	2		2	1					9	12	44		3	47	65	56	77
Missouri																													2		2	
Montana	1						1			2	5			7	1						2			3	1	10		2	12	21	15	22
Nebraska	1						1		1	3	5			8	4						1		4	9	4	20		2	22	14	31	18
Nevada											1			1												2			2		2	
New Mexico	1									1	6		2	9	5		4	3			2		1	15	17	31		6	37	23	52	40
North Dakota																										1			1		1	
Ohio																					1		3	4	2	10			10	5	14	7
Oklahoma	6		2	1						9	56			65	28		4	8		1	12	2	2	57	61	264			264	211	321	272
South Dakota																													2		2	
Tennessee																													4		4	
Texas	45	7	9	15	3	1	6		5	91	291	1	24	407	197	22	36	76	7	11	32	7	13	401	329	1302	3	119	1424	1114	1825	1443
Dist. 1 S. Central			1				1			2	21		3	26	10			2	1		1		1	15	8	75		9	84	80	99	88
Dist. 2 Middle Gulf		2	2	2		1			2	9	22		2	33	4	6	8	13		6	2		3	42	24	75		19	94	54	136	78
Dist. 3 Upper Gulf		2	1	1					1	5	23		1	29	8	6	8	15	2	2	1	1	2	45	38	103		3	106	82	151	120
Dist. 4 L. Gulf-S.W.	4		1	4	2				2	13	27		2	42	15	4	3	17	3	2	2	1	4	51	42	114	1	17	132	121	183	163
Dist. 5—E. Central	2	1					1			4	15			19	3	2		2			4			11	3	74		1	75	26	86	29
Dist. 6 Northeast											5		1	6	3	1		1			1	5		11	12	28		1	29	39	40	51
Dist. 7-B N. Cent.	17		2	2						21	78		4	103	68		9	7			3		2	89	67	357		8	365	243	454	310
Dist. 7-C W. Cent.	6		1		1					8	19		1	28	25	1	2	2	2		4			36	17	107		3	110	80	146	97
Dist. 8 West	7		1	1			2			11	25	1	2	39	23		3	8			7			41	60	145	2	11	158	125	199	185
Dist. 9 North	8	2		5			2			17	53		8	78	36	2		10		1	7		1	57	57	215		47	262	260	319	317
Dist. 10 Panhandle	1									1	3			4	2		1							3	1	9			9	4	12	5
Utah											4			4	1									1	1	11			11	4	12	5
Washington																														2		2
West Virginia																	2							2							2	
Wyoming	3						1			4	9		1	14	6			5		1	5			17	8	34		7	41	33	58	41
Total U.S.	89	8	13	27	4	1	18	1	7	168	704	1	29	902	360	25	54	147	10	17	85	10	24	732	619	2879	5	173	3057	2564	3789	3183

BJ engineering puts power to work for you...

BJ POWER TONG

spins and makes up drill pipe and casing with money-saving speed!

Here's another example of how BJ engineering puts power to work for you. With the BJ Power Tong on your rig you eliminate dangerous spinning rope and chain . . . run pipe faster . . . cut manual labor.

Spins and makes up—Tong's air power driven rollers spin joint tight . . . jerk line is used for final make-up.

One-man operation—Operator latches and removes BJ Power Tong from joint by means of single control handle . . . *latch action is automatic!*

True balance, rugged construction—Provides perfect alignment with the pipe . . . easy handling . . . has same exclusive balancing feature of other BJ Tongs.

Reversible—BJ Power Tong can be turned over and used when pulling out of the hole.

Wide size range—4"-7¾" O.D. drill pipe and casing can be used with BJ Power Tong thru 3 sizes of quickly changed lug jaws.

Talk with your BJ Representative to get detailed facts on how you can boost efficiency and cut costs with the BJ Power Tong,

BJ

MEANS ENGINEERED OIL TOOLS

Byron Jackson Co.

Since 1872

MAIN OFFICE & PLANT: LOS ANGELES 54, CALIF.

Mid-Continent Office & Plant: Houston 1, Texas

Export Office: New York 17, New York

JOBBERS IN ALL PRINCIPAL OIL FIELDS

U. S. Oil, Distillate and Gas Discoveries and Extensions in May

U. S. OIL, DISTILLATE AND GAS DISCOVERIES AND EXTENSIONS IN MAY

ARKANSAS—NEW OIL PAY

Union County, Schuler, East field. Atlantic Refining Company's J. M. Bishop 2, C SE NW SW 13-18s-17w, flowed 140 barrels from Pettit lime, Lower Cretaceous 3927-3932 feet, 44.5-gravity, 10/64-inch, completed 5-19-51, TD 4001.

ARKANSAS—OIL FIELD EXTENSION

Columbia County, Shongaloo, North field. Stanolind Oil & Gas Company's Pine Woods Lumber Company 1, in 11-20s-22w, 1-mile north extension, flowed 267 barrels from Pettit lime, Lower Cretaceous 3927-3932 feet, 44.5-gravity, 10/64-inch, completed 5-19-51, TD 4001.

Kern County. Humble Oil& Refining Company's KCL B-1 in 35-11n-21w, pumped 50 barrels from 4275-4335 feet, 17-gravity, completed 5-27-51, TD 5451.

Unnamed field. Pacific Western Oil Company's M-MA 42-30, in 30-30s-22e, flowed 1149 barrels from Oceanic sand, Eocene 4971-5039 feet, 35.4-gravity, 25/64-inch, completed 5-19-51, TD 5039.

Santa Barbara County, Cuyama, Central field. Seaboard Oil Company's Seaboard-Richfield-Kirschenmann 78-22, in 22-10-n-26w, pumped 111 barrels from 7278-7372 feet, 46-gravity, completed 5-8-51, TD 10,097.

CALIFORNIA—NEW OIL PAY

Los Angeles County, Newhall-Townsite field. Tevis F. Morrow's Grayson 1, in 1-3n-16w, pumped 90 barrels from 3291-3371 feet, 21-gravity, completed 5-7-51, TD 3422.

CALIFORNIA—GAS FIELD EXTENSION

Humboldt County, Tompkins Hill field. The Texas Company's Holmes-Eureka 5, in 23-3n-1w, ½-mile east extension, flowed 0.2-million from 4365-4695 feet, completed 5-22-51, TD 5100.

ILLINOIS—NEW OIL FIELDS

Christian County, Pana field. Collins Brothers Oil Company's R. T. Jones 1, NE NE NE 3-11n-1e, pumped 20 barrels and 20 barrels water from Bethel sand, Mississippian 1472-1482 feet, completed 5-15-51, TD 2847.

Lawrence County, Pinkstaff field. Cherry & Beebe's W. E. Conrad 1, SE SW NW 9-4n-11w, pumped 15 barrels and 65 barrels of water from McClosky lime, Mississippian 1734-1738 feet, completed 5-22-51, TD 1797.

Wabash County, Bellmont field. George Ellison's H. Epler 1, NE SE NE 36-1s-14w, pumped 240 barrels from McClosky lime, Mississippian 2836-2845 feet, completed 5-22-51, TD 2847.

Washington County, Okawville field. E. A. Obering's Baldwin 1, NE SE SE 15-1s-4w, pumped 56 barrels from Devonian-Silurian lime, 2323-2332 feet, completed 5-22-51, TD 2336.

ILLINOIS—NEW OIL PAY

Richland County, Calhoun, Central field. George & Wrather's M. Beach 1, NW SE NW 10-2n-10e, ½-mile south of production, pumped 54 barrels from Rosiclare lime, Mississippian 3247-3253 feet, completed 5-29-51, TD 3291.

ILLINOIS—OIL FIELD EXTENSIONS

Clay County, Clay City-Noble Consolidated field. W. W. Toler's Manker 1, SW NE SE 17-3n-8e, 1-mile northeast extension, pumped 40 barrels from Aux Vases sand, Mississippian 2911-2919 feet, completed 5-22-51, TD 2924.

Effingham County, Eberle field. Robinson-

THE BIG FOUR MACHINE & SUPPLY CO.

wishes to ***ANNOUNCE*** *that*

Baash-Ross Tool Co.

are

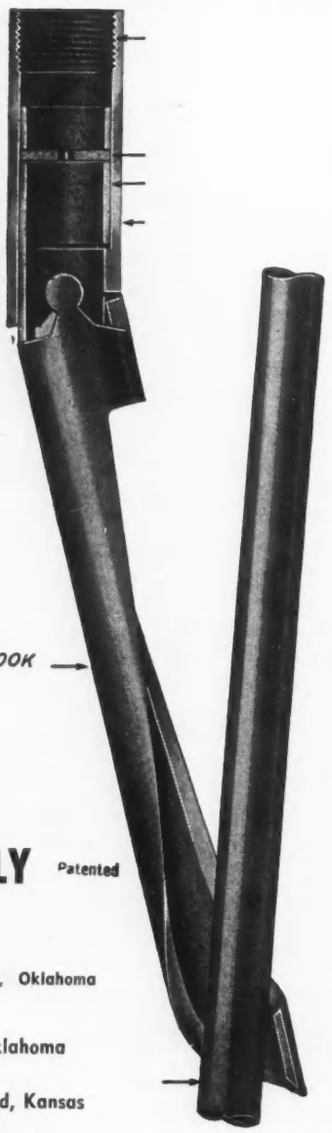
SERVICE AGENTS

for

BIG FOUR

Hydraulic Wall Hooks

and recommend our Wall Hooks on all fishing jobs where a fishing tool of this type is required.



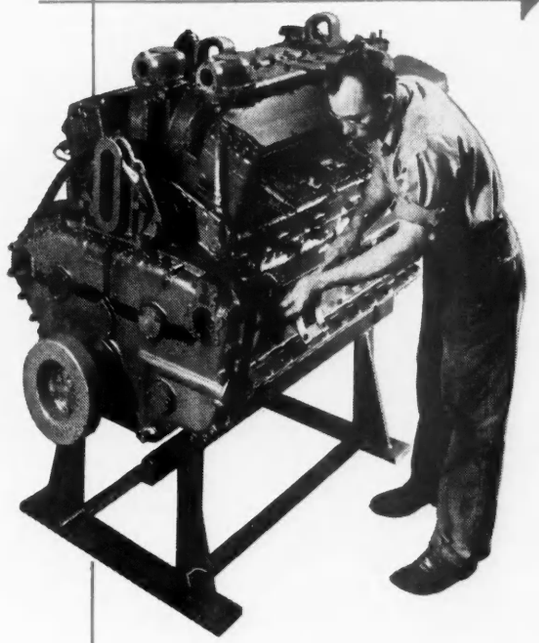
BIG FOUR MACHINE AND SUPPLY COMPANY

Made in a variety of sizes—there's one to fit every fishing job.

BIG FOUR MACHINE AND SUPPLY COMPANY Patented

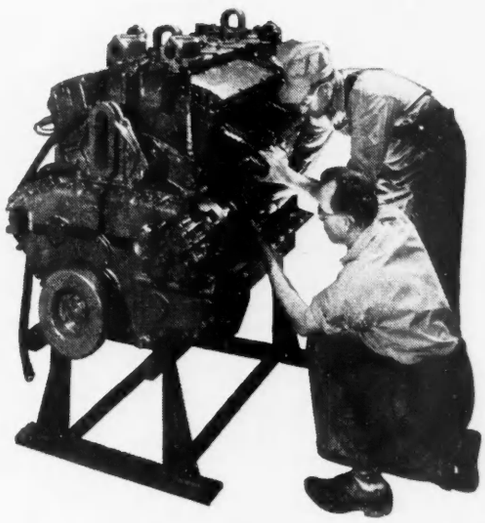
Main Office: 1013-14 Hales Building, Oklahoma City, Oklahoma
Phone 79-1139
Box 256, Clay City, Illinois
Box 477, Pawhuska, Oklahoma
BEAVER TOOL & MACHINE CO., Maysville, Oklahoma
Manufacturers of Big Four Products
Complete Warehouse Stocks Available at:
C & W MACHINE WORKS COMPANY, Great Bend, Kansas
TILLERY AND PARKS, Odessa, Texas
Export Office: 233 Broadway, New York 7, New York

BUILT NOT ONCE BUT TWICE!



Cummins is the custom-builder of the Diesel industry. Each engine is built to *fit the job*—and the individual piece of equipment in which it is to be installed. And *every* Cummins engine is built *twice*. First, each engine is assembled, run-in tested. Then it is disassembled completely, and inspected. Finally it is reassembled and tested *again*. This extra care in precision building, Cummins exclusive fuel system, efficient parts and service organization . . . mean *less* "down-time" and *more* power and profits for Cummins users. *See your Cummins dealer.*

Cummins®
CUSTOM BUILT Diesels



Lightweight High-speed Diesel Engines (50-550 hp)
for: on-highway trucks
off-highway trucks • buses
tractors • earthmovers
shovels • cranes
industrial locomotives
air compressors
logging yarders and loaders
drilling rigs
centrifugal pumps
generator sets and power units
work boats and pleasure craft

CUMMINS ENGINE COMPANY, INC., COLUMBUS, INDIANA
Export: CUMMINS DIESEL EXPORT CORPORATION • Columbus, Indiana, U.S.A. • Cable: CUMDIEX

Diesel power by CUMMINS

CUMMINS Dependable DIESEL

TRADEMARK REG. U. S. PAT. OFF.

Puckett, Incorporated's Becker 1, NW NW SE 23-6n-6e, ¾-mile northwest extension, pumped 28 barrels from Rosiclare lime, Mississippian 2680-2685 feet, completed 5-22-51, TD 2686.

Gallatin County, Inman, West Consolidated field. H. E. Howard's M. Mills 1, NE NW SE 26-8s-9e, ¾-mile east extension, pumped 135 barrels and 45 barrels of water from Cypress sand, Mississippian 2472-2488 feet, and Aux Vases sand, Mississippian 2766-2780 feet, completed 5-15-51, TD 2788.

Wayne County, Ellery, West field. McGregor's Fisher 1, NW NE NE 34-2s-9e, ¾-mile south extension, pumped 55 barrels and 55 barrels of water from McClosky lime, Mississippian 3364-3372 feet, completed 5-8-51, TD 3400.

White County, Maunie, South field. Farrell & Ripley's Westergard Heirs 1, NW NW SW 30-6s-11e, ¾-mile south extension, pumped 24 barrels from Degonia sand, Mississippian 1904-1909 feet, completed 5-29-51, TD 2999.

INDIANA—NEW OIL FIELD

Vigo County. T & H Corporation's Theodore A. Bettenbrock 1, in 36-12n-9w, pumped 150 barrels from Devonian lime, Devonian 1625-1646 feet, TD 1653.

KANSAS—NEW OIL FIELDS

Barton County, Fort Zarah, Southeast field. G-M-R Oil Company's Stark 1, NE NE NW 32-19s-12w, pumped 168 barrels from Arbuckle lime, Ordovician 3384-3388 feet, TD 3388.

Foster Spinning Cathead

SPEED . . . instant engagement without reducing lineshaft speed.
ECONOMICAL . . . will spin and tong with forked line.
DEPENDABLE . . . heavy bearings, well lubricated . . . records of years of operation without repairs.
SAFETY . . . eliminates hand-wrapping of spinning line.

Foster Master, Type B, Breakout Cathead

SPEED . . . instant engagement without reducing lineshaft speed.
ECONOMICAL . . . no metal-to-metal impacts . . . no complicated brake necessary.
DEPENDABLE . . . powerful friction clutch . . . roller bearings.
FLEXIBLE . . . recommended for either air or manual controls.

"Speed with control has been built into Foster Catheads for the 26 years we have been specializing in their manufacture. The driller operates Foster Catheads from his regular position, and there's no time lost waiting for the shaft to slow down because powerful friction clutches engage with the cathead shaft running at high speed." Sold thru supply stores everywhere.

In addition, the Foster Cathead Company manufactures the Air Master Breakout, Foster Air Spinning Cathead, plus the Foster Midget Master Breakout Cathead and Foster Midget Spinning Cathead for shallow drilling and clean-out rigs.

Foster CATHEAD COMPANY
P. O. BOX 1675 WICHITA FALLS, TEXAS

FACTORY REPRESENTATIVES

O. W. Frogge, Casper, Wyoming
Tillery & Parks, Odessa, Texas
R. D. Cloninger, Lafayette, Louisiana

Sandrock field. Adkins Drilling Company's Sandrock 1, SW SW SE 21-20s-13w, jumped 42 barrels from Lansing-KC lime, Pennsylvanian 3412-3420 feet, TD 3590.

Ellis County, Karlin field. Fred Nixon et al's Karlin 1, NW SW NE 14-13s-17w, pumped 77 barrels from Lansing-KC lime, Pennsylvanian 3348-3352 feet, TD 3568.

Ellsworth County, Plum Creek field. B & R Drilling Company's Novotny 1, NW NE NE 32-16s-10w, pumped 48 barrels from Arbuckle lime, Ordovician 3299-3303 feet, TD 3304.

Gove County, Coberly field. Cities Service Oil Company's Coberly 1, NW SE SE 15-14s-29w, pumped 3000 barrels from Marmaton lime, Pennsylvanian 4287-4298 feet, 30.5-gravity, TD 4644.

Rooks County, Lynd field. Jones, Shelburn & Farmer's Lynd 1, SE SE SE 32-9s-19w, pumped 79 barrels from Arbuckle lime, Ordovician 3747-3757 feet, TD 3757.

Marcotte South field. Derby Oil Company et al's Rogers A-1, SW SW SW 22-10s-20w, pumped 199 barrels from Arbuckle lime, Ordovician 3710-3726 feet, TD 3726.

Saline County, Ryding field. Phillips & Sanderson's Ryding 1, NW NW NW 1-16s-4w, pumped 508 barrels from Viola lime, Ordovician 3439-3443 feet, TD 3443.

Sedgwick County, Minneha field. A. D. Allison & Aledo Oil & Gas Company's Faulk 1, SE SW SE 11-27s-2e, flowed 144 barrels from Arbuckle lime, Ordovician 3247-3251 feet, TD 3288.

Stafford County, Black Cloud field. Armer Drilling Company's Anderson 1, NW NW SW 2-21s-12w, pumped 14 barrels and 5 barrels of water from Arbuckle lime, Ordovician 3460-3466 feet, TD 3466.

Byron field. Duke & Woods Drilling Company's Burhenn 1, NW NW NE 9-21s-12w, pumped 21 barrels from Arbuckle lime, Ordovician 3372-3377, TD 3492.

Stafford County, Lincoln field. Petroleum, Incorporated's Lincoln 1, NW SE SE 29-21s-14w, pumped 1674 barrels from Lansing-KC lime, Ordovician 3543-3551 feet, TD 3849.

Sumner County, Lee field. Capitt Drilling Company et al's Lee 1, C S½ SE NE 33-32s-2e, pumped 25 barrels from Mississippi lime, Mississippian 3349-3359, TD 3359.

Trego County, Ogallah field. Pyramid Drilling Company's Schoenthaler 1, SE SW SE 26-12s-22w, flowed 1397 barrels from Arbuckle lime, Ordovician 3972-3990 feet, TD 3990.

Wabaunsee County, Wheat field. Carter Oil Company's Wheat 1, NW SE NE 10-15s-11e, pumped 40 barrels from Simpson dolomite, Ordovician 3230-3234 feet, TD 3234.

KANSAS—NEW OIL PAYS

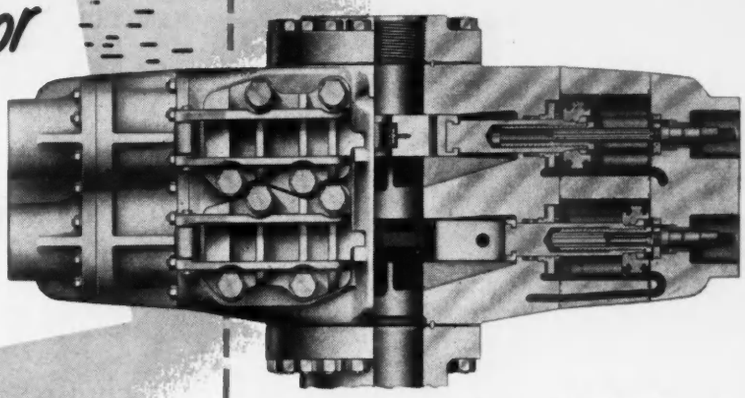
Meade County, Novinger field. Columbian & United's Novinger 1 (OWWO), C NW NW 26-33s-30w, flowed 1675 barrels from Marmaton lime, Pennsylvanian 5270-5290 feet, TD 6638.

Pratt County, Chance field. The Texas Company's Luke Mowbray 1, SE SE SE 29-26s-13w, flowed 213 barrels from Mississippi lime, Mississippian 4254-4279 feet, TD 4334.

Stafford County, Duggan field. Midge Oil Company's Salem 1, NE SE SE 26-21s-2w, pumped 639 barrels from Lansing-

In this gate Simply Swing Open a Door to Change the Rams!

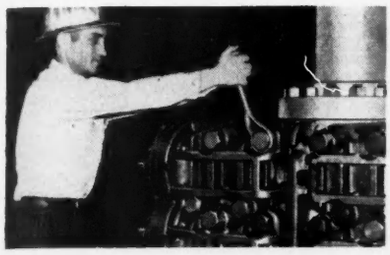
- whether pipe is in or out of the hole!



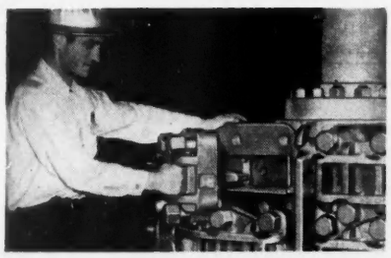
The Shaffer Hydraulic Double Cellar Control Gate (above) combines two separate ram compartments in ONE *body for maximum compactness. The Shaffer Hydraulic Single Cellar Control Gate is also available, if desired.*

SHAFFER HYDRAULIC CELLER CONTROL GATES

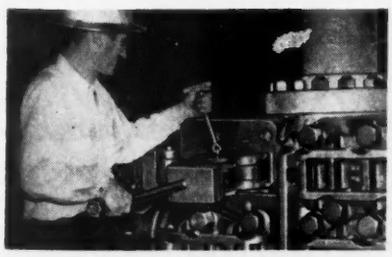
make ram changing as simple as this . . .



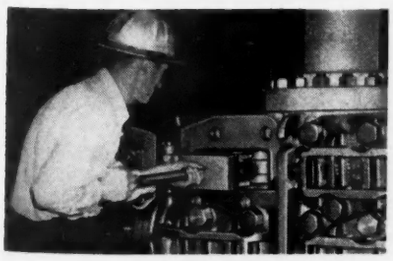
1. UNBOLT TWO DOORS in the side of the Gate by simply loosening four bolts in each door. The bolts remain in the doors where they won't be lost.



2. SWING THE DOORS OPEN and pull out the ram assembly. There is nothing to manually unlock and disengage—the complete ram assembly pulls right out.



3. LIFT THE RAMS from the Gate and replace the ram blocks and rubbers with others of the desired size—a quick and easy operation.



4. SLIDE THE RAM ASSEMBLY back into the Gate and bolt the doors. Guide ribs on the doors automatically align the ram assemblies as doors close.

AND NOTE THIS—*since the rams are changed from the side—not the end of the Gate, you can make a complete ram change with equal ease whether the pipe is in or out of the hole!*

Unequalled speed and simplicity in changing rams is only one of the many major advantages designed into Shaffer Hydraulic Cellar Control Gates. Other unique features are briefly outlined at right, but be sure to get the *complete* story on this Shaffer product before you buy *any* cellar control gate equipment. *No other equipment provides so much protection—in so small a space—with so many vital advantages!*

FOUR OTHER VITAL SHAFFER ADVANTAGES

Amazing Compactness—The Double Gate combines *two* separate ram compartments unitized into *one* body with an overall height of only 30" even in sizes as large as 13⅜" (12" Series 900). The Single Gate of like size, with one ram compartment, is considerably less in height than any other hydraulic gate on the market, measuring only 18½" high overall!

Fully Enclosed Design—with all moving parts, including piston rod ram shafts, completely enclosed within the body of the Gate. There are no outside moving parts to become wedged or damaged by objects falling into the cellar—or become corroded by chemical and salt drippings. Even the locking shaft is non-rising, fully protected!

Direct Hydraulic Drive—with the hydraulic operating cylinders *directly behind* each ram for maximum simplicity and safety. There are no complicated indirect connections between hydraulic cylinders and rams!

Quick Draining Body—with the rams traveling on high narrow guide ribs above the steeply-sloped bottoms of the ram compartments. Mud and sand quickly drain back into the well—no detrimental accumulations to interfere with free ram travel!

These and still other vital advantages combine to make the Shaffer Hydraulic Cellar Control Gate the most advanced hydraulic gate available today. Before you buy *any* control gate equipment, be sure to get the complete story from your nearby Shaffer representative—or write direct.

Write for your free copy of the new 1951 Shaffer Catalog. See Shaffer section—pages 4525 to 4600—of the 1951 Composite Catalog.

28 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
EXPORT SALES OFFICE, Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

KC lime, Pennsylvanian 3312-3334 feet, TD 3581.

KANSAS—NEW GAS FIELDS

McPherson County. Aladdin Petroleum Corporation & Crowe Drilling Company's Goering 1, SW SW SW 4-21s-1w, flowed 2.1-million from Mississippi lime, Mississippian 2955-2978 feet, TD 3556.

Morton County. Cities Service Oil Company's Greenwood B-1, NE NE NW 14-33s-42w, no gauge from Morrow sand, Pennsylvanian 4872-4880 feet, TD 6000.

KENTUCKY—NEW OIL FIELD

Muhlenberg County, Hunts School field. P. H. Gray Trustees' Willard Hunt 1, NE NW NW 21-H-31, pumped 12 barrels from Jackson sand, Mississippian 525-540 feet, TD 540.

KENTUCKY—NEW OIL PAYS

Henderson County, Oak Grove field. George A. Hoffman et al's Powell S. Nunley 1, in 19-P-25, pumped 20 barrels from Aux Vases lime, Upper Mississippian 2102-2107 feet, TD 2344.

Henderson County, Tunnell Hill field. G. L. Reasor's Raleigh 1, in 5-N-23, pumped 132 barrels from O'Hara lime, Lower Mississippian 2623-2634 feet, TD 2778.

Zion field. F. M. Ashby & Ashland's H. H. Gregory 1, SW NW NW 1-P-25, pumped 250 barrels from Waltersburg sand, Upper Mississippian 2231-2236 feet, TD 2257.

KENTUCKY—OIL FIELD EXTENSIONS

Henderson County, Spottsville field. R. E. Hupps, Chester Oil Company & George Hoffman's E. O. Kerney 1, SE SW NW 21-Q-25, ½-mile northeast extension, pumped and flowed 200 barrels from Lower O'Hara lime, Lower Mississippian 2142-2148 feet, TD 2274.

Zion field. Joe Blalock's M. B. Quinn Heirs 1, SW NW NE 9-P-25, ½-mile south extension, flowed 40 barrels from McClosky lime, Lower Mississippian 2165-2179 feet, TD 2181.

NORTH LOUISIANA—NEW OIL FIELDS

Caddo Parish. D. C. Carnes' Kennonwood Corporation 1, in 5-19n-15w, flowed 30 barrels from Paluxy sand, Lower Cretaceous 2340-2346 feet, 41-gravity, ⅛-inch, completed 5-7-51, TD 2451.

Unnamed field. D. C. Carnes' Slattery 1, SW SE SW 15-19n-15w, flowed 60 barrels from Paluxy sand, Lower Cretaceous 2435-2450 feet, 44.3-gravity, 7/64-inch, completed 5-11-51, TD 2558.

LaSalle Parish, "Rogers" field. J. S. Michael Company's Nebo Oil Company C-2, C SW NE 9-6n-3e, flowed 309 barrels from Wilcox sand, Eocene 3984-3989 feet, 42.9-gravity, 11/64-inch, completed 5-6-51, TD 4515.

Unnamed field. Placid Oil Company's State of Louisiana C-1, Catahoula Lake, C SE SE 15-6n-3e, pumped 65 barrels from Wilcox sand, Eocene 4409-4411 feet, completed 5-4-51, TD 5600.

NORTH LOUISIANA—OIL FIELD EXTENSION

Richland Parish, Big Creek field. J. A. Harper Oil Company's Burkett 1, C SW SE NW 3-16n-7e, 1-mile north extension, flowed 44 barrels from Tuscaloosa sand, Upper Cretaceous 2631-2648 feet, 9/64-inch, completed 5-12-51, TD 2798.

NORTH LOUISIANA—DISTILLATE FIELD EXTENSION

Bienville Parish, Lake Bistineau field. Munoco Company's Cagle 1, in 18-16n-9w, ½-mile east extension, flowed 8.5-million gas and distillate from Upper Pettit lime, Lower Cretaceous 5169-5262 feet, completed 5-3-51, TD 5840.

SOUTH LOUISIANA—NEW OIL FIELD

Allen Parish, "Reeves" field. Niloco Company & Bel Oil Corporation's Bel-Krause 1, in 25-6s-7w, flowed 52 barrels from Frio sand, Oligocene 5888-5890 feet, 27.8-gravity, 5/64-inch, completed 5-2-51, TD 7515.

SOUTH LOUISIANA—NEW OIL PAY

Lafourche Parish, Clovelly field. Superior Oil Company and Clovelly Corporation's Clovelly Corporation 2, in 33-18s-22e, flowed 220 barrels from 12,790-12,815 feet, 30.8-gravity, 7/64-inch, completed 5-24-51, TD 13,070.

SOUTH LOUISIANA—NEW DISTILLATE FIELD

St. Mary Parish. Shell Oil Company, Incorporated's State Lease 1593-1, Township 18s-10e, flowed 74 barrels and 3.6-

INFORMED CREWS CAN PREVENT LOST CIRCULATION AND BLOWOUTS

WITH "Pit-O-Graf"

The Pit-O-Graf automatically records the mud pit level on a twenty-four hour basis. A gain in mud, indicating the presence of a high pressure formation, which might cause a blowout, is recorded on the chart in sufficient time for counteracting measures to be taken. Loss of mud to thief formations, which could lead to loss of circulation, is indicated immediately by the Pit-O-Graf. The Pit-O-Graf chart furnishes a time record of every connection, trip, and all other drilling operations. In addition, an alarm system can be installed that will warn the driller and crew of any variations in pit level.

Write today for complete information showing how the Pit-O-Graf will save you time and money.

CHECK THESE ADVANTAGES:

- Records mud pit level automatically.
- An optional alarm system warns driller of any variations in level.
- Prevents loss of circulation by indicating loss of mud to formations.
- Helps prevent blowouts by warning of high pressure formations.
- Provides a time record of every connection, trip, and all other drilling operations.
- Proved in over six years of hard field use.

WARREN AUTOMATIC TOOL CO.
1920 HUSSION ST. - HOUSTON, TEXAS
LAFAYETTE, LA - ODESSA, TEXAS

... another reason why drillers prefer

Standco NO-SMOKE BRAKE LINING

Standco Brake Blocks are made of cabled cords of long fibre asbestos — woven solid and reinforced with bronze wire to prevent pulling loose on the bolts. They will not burn or smoke or score brake rims.

More deep wells have been drilled with Standco than with all other blocks combined. It's your answer for low-cost hole-making.

STANDCO BRAKE LINING COMPANY
Factory and General Offices
2701-2801 Clinton Drive — Houston, Texas

These Facts Prove Beyond Any Doubt That Goodall Long-Life Is

A BETTER BUY

On Every Count Than Any Other Rotary Hose

1. COUPLING - The original Barney Coupling is the only coupling that is stronger than the hose itself. It is the only coupling that can be reset to save your hose from the scrap heap.
2. CORD CONSTRUCTION - Goodall's flexible cord design provides the extra strength to withstand torsional twist . . . thus eliminating the cause of more than 90% of rotary hose failures.
3. FLEXIBILITY - Goodall Long-Life can be coiled into a convenient unit for transporting without slightest damage.
4. PERFECT BALANCE - The Goodall method of winding the multiple cords of the carcass and the steel cables of the pressure element at corresponding angles assures perfect balance.
5. GREATER STRENGTH - By actual test, Goodall Long-Life is the strongest hose ever built and it retains its strength better than any other hose.
6. REPAIR SERVICE - Goodall Rubber Company is the only rotary hose manufacturer that can protect your investment with a maintenance plan. Goodall maintenance provides a repair department in Houston where any length of Long-Life that meets with an accident can be renewed for the rest of its normal life. No length of Long-Life repaired in our shop has ever failed in service.
7. SALVAGE VALUE - Substantial allowances are made on every set of Barney couplings returned.
8. NO PREMIUM PRICE - The extra quality, longlife and high salvage value of Goodall Flexible Cord costs no more than ordinary rotary hose.

If you are not fully convinced of these facts, ask anybody who makes or sells rotary hose or write to me personally. We will contact you and fill in other details and answer your questions. Thanks.

Barney

GOODALL RUBBER COMPANY
TRENTON, N. J.

GOODALL RUBBER COMPANY OF TEXAS: Houston, Texas.
GOODALL RUBBER COMPANY OF CALIFORNIA: San Francisco, Los Angeles, Seattle, Salt Lake City.
GOODALL RUBBER COMPANY: New York, Philadelphia, Pittsburgh, Chicago, Denver, St. Paul.
EXPORT: Goodall Rubber Company, Trenton, N. J.
DISTRIBUTORS: Texas and Louisiana — Houston Oil Field Material Co.; Wilson Supply Co.
Oklahoma — Iverson Supply Co.

Goodall Has Been FIRST With Every Worthwhile Rotary Hose Development!

million from 9535-9542 feet, 51.5-gravity, 14/64-inch, completed 5-14-51, TD 14,697.

SOUTH LOUISIANA—NEW DISTILLATE PAY

Plaquemines Parish, Cox Bay field. Richardson & Bass' State Lease 20-H-1794-Cox Bay Unit 4, in 17-18s-16e, flowed 300 barrels and 1.4-million from 8500-8503 feet, 55.2-gravity, ⅛-inch, completed 5-28-51, TD 11,335.

MICHIGAN—NEW OIL PAY

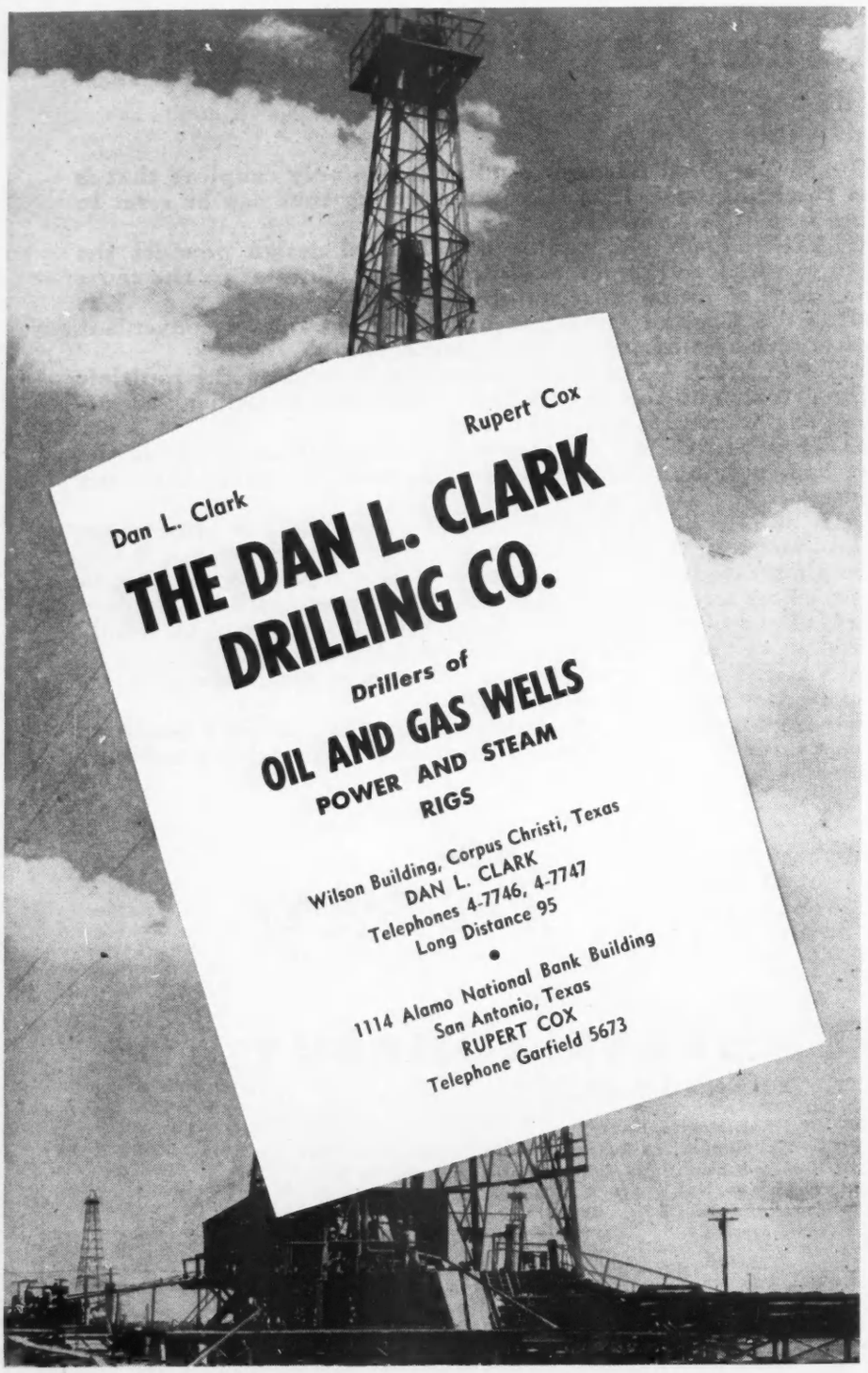
Oceana County, Mears field. McClure Oil Company's Forestry Association 1, NE NE SW 35-15n-18w, flowed 50 barrels from Traverse lime, Devonian 1742-1746 feet, TD 1746.

MISSISSIPPI—NEW OIL FIELDS

Adams County, "Gardens" field. Kemp Drilling Company's Mrs. Ruth M. Gilbert 1, in 12-7n-3w, flowed 120 barrels from Wilcox sand, Eocene 4403-4405 feet, 7/64-inch, completed 4-17-51, TD 6511.

Wayne County. Humble's Mrs. J. B. Mayfield 1, C NE SW NE 17-9n-7w, pumped 166 barrels from Stanley sand, Upper Cretaceous 4598-4603 feet, 16.4-gravity, completed 5-31-51, TD 4845.

Wilkinson County, Lessley, North field. John Brook, Jr., & Petersen Drilling Company et al's Louis Wax 1, C NW NE 36-3n-3w, pumped 250 barrels from Wilcox sand, Eocene 7299-7303 feet, 32.9-gravity, completed 5-7-51, TD 8461.



MONTANA—NEW OIL FIELD

Teton County. E. B. Emrick's Rencurel 1, NE NE SW 31-28n-4w, pumped 68 barrels from Madison lime, Lower Mississippian 2092-2094 feet, TD 2094.

MONTANA—OIL FIELD EXTENSION

Glacier County, Cut Bank field. Stewart & Pattie's B. Swenson 1, C NW SE 13-37n-5w, ½-mile northeast extension, flowed 13 barrels from Moulton sand, Upper Cretaceous 2512-2532 feet, 40-gravity, completed 5-17-51, TD 2565.

NEBRASKA—NEW OIL FIELD

Cheyenne County, "Johnson" field. Ohio Oil Company's Robert W. Johnson 1, SE SE SW 35-15n-19w, pumped 222 barrels from 3rd Dakota sand, Lower Cretaceous 4584-4590 feet, completed 5-21-51, TD 4656.

NEBRASKA—OIL FIELD EXTENSION

Banner County, Harrisburg field. Stanolind's & Kerr McGee's H. A. Downer 1, C SW NW 5-18n-55w, ½-mile northeast extension, pumped 265 barrels from 2nd Muddy "J" sand, Upper Cretaceous 5868-5898 feet, completed 5-2-51, TD 7185.

NEBRASKA—GAS FIELD EXTENSION

Deuel County, Big Springs field. Superior's I. H. Koehler 18-5, SW SW SW 5-13n-42w, ½-mile north extension, flowed 5-million from 1st Dakota "D" sand, Lower Cretaceous 3297-3312 feet, ½-inch, completed 5-9-51, TD 3380.

NEW MEXICO—NEW OIL FIELD

Rio Arriba County. Magnolia Petroleum Company's Ingwersen 1, C SE SE 20-24n-2w, pumped 68 barrels and 13 barrels water from Dakota sand, Lower Cretaceous, 7740-7745 feet, completed 4-24-51, TD 7805.

OKLAHOMA—NEW OIL FIELDS

Carter County. Stanolind's Mattie Elmore 1, SW NW SW 18-2s-3w, pumped 60 barrels from Pennsylvanian sand, Pennsylvanian 4460-4510 feet, 34-gravity, TD 4797.

Kay County, Chilocco, East field. Dean Witter's Widener 1, SE NW NW 20-29n-3e, pumped 42 barrels and 70 barrels water from Bartlesville sand, Pennsylvanian 3218-3220 feet, 41.2-gravity, TD 3222.

Lincoln County, Davenport, Southwest field. Republic Natural Gas Company's Stewart 1 NE NE SW 19-14n-5e, flowed 79 barrels from Prue sand, Pennsylvanian 3610-3614 feet, 45-gravity, ½-inch, TD 4860.

Osage County. Service Drilling Company's Osage 1, SE NE SE 5-24n-7e, flowed 96 barrels from Burbank sand, Pennsylvanian 2670-2710 feet, TD 2711.

Stephens County. Peppers Refining Company's Smith 1, NW SW SE 4-2n-8w, pumped 20 barrels and 40 barrels of water from Hoxbar sand, Pennsylvanian 6715-6730 feet, 36-gravity, TD 7503.

Unnamed field. Skelly Oil Company's O-C-U 1, NE NE NE 14-2s-4w, pumped 76 barrels from Pennsylvanian sand, Pennsylvanian 4154-4167 feet, 34-gravity, TD 5054.

OKLAHOMA—NEW OIL PAY

Lincoln County, Davenport, West field. Thompson & Harris' Gibbons Heirs 1, NW NE SW 17-14n-5e, ¾-mile south-

1851-1951 . . . One Hundred Years of Engineering Leadership

JOY
MOTORIZED DRILL RIGS

Most ADVANCED in Design—
Most EFFICIENT in Operation!

Available in a range of heavy-duty models for exploration drilling, seismograph, water well, electrical logging or slim-hole production drilling to 5000′. JOY Drill Rigs incorporate many exclusive features you'll like, because they're built by practical engineers—men who know oil-field drilling from the grass roots down. ● For speed, endurance, mobility and economy, your best bet is a JOY rig—built by the world's oldest and largest producer of core drills and motorized drill rigs.

Write for Bulletin, or

Consult a Joy Engineer

W&D O 3002

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

east of production, flowed 154 barrels from Prue sand, Pennsylvanian 3556-3566, 47-gravity, ¼-inch, TD 3566.

OKLAHOMA—NEW GAS FIELDS

Creek County. H. V. Pickett & J. E. Chile's Beaver 1, NW NE NE 12-17n-8e, flowed 2.5-million from Skinner sand, Pennsylvanian 2339-2359 feet, TD 2380.

Hughes County. Skelly's A. F. Lyons 1, NW SE NW 33-6n-10e, flowed 0.7-million from 2nd Gilcrease sand, Pennsylvanian 4103-4112 feet, TD 5461.

TEXAS DISTRICT 1—OIL FIELD EXTENSION

McMullen County, Campana, South field. Sunray Oil Corporation's J. P. Driggs 1, BS&F Survey, ½-mile south extension, pumped 31 barrels and 24 barrels water from Pettus sand, Eocene 3027-3030 feet, completed 5-27-51, TD 3033.

TEXAS DISTRICT 1—NEW GAS FIELD

McMullen County. Newman Brothers Drilling Company & Alaska Steamship Company's Mrs. Ethel Lowe Craig 1, J. Poitevent Survey, flowed 1.4-million from Wilcox sand, Eocene 5473-5488 feet, ⅛-inch, completed 4-24-51, TD 6246.

TEXAS DISTRICT 2—NEW OIL PAYS

Bee County, Blanconia, South field. Bridwell Oil Company's H. C. Wood A-4, James McGeehan Survey, flowed 66 barrels from 5326-5329 feet, 3/32-inch, completed 4-15-51, TD 5329.

Victoria County, McFaddin, East field. Union Producing Company et al's McFaddin et al 29-A, Maria J. Traviesa Grant, flowed 34 barrels from 5222-5223 feet, 35.1-gravity, ⅛-inch, completed 4-26-51, TD 6415.

TEXAS DISTRICT 2—NEW DISTILLATE FIELDS

Calhoun County, "Long Mott, South" field. Quintana Petroleum Corporation's Mrs. Jamie Hynes 2, J. F. de la Fuentes Survey, no gauge from Frio sand, Oligocene 7600-7620 feet, completed 4-24-51, TD 8600.

Live Oak County. Delhi Oil Corporation's R. C. Lyne 1, Dr. C. F. Simmons Farm Lots Subdivision Survey, flowed 17-million gas and distillate from Mackhank sand, Eocene 7420-7440 feet, open, completed 5-3-51, TD 7718.

TEXAS DISTRICT 2—NEW GAS FIELDS

Refugio County. P. R. Rutherford's William Avery 1 (OWWO), Edward Perry League, flowed 75-million from 2272-2287 feet, open, completed 4-24-51, TD 6559.

Victoria County. Sunray's McFaddin 11-A, Augustin L. Fernet Grant, flowed 3-million from 5123-5128 feet, open, completed 5-2-51, TD 6500.

TEXAS DISTRICT 2—NEW GAS PAY

Bee County, Sliva field. Miller Wells, Incorporated's Lado Muhlstein et ux 1, Jackson M. Reed Survey, no gauge from Vicksburg sand, Oligocene 4400-4406 feet, completed 4-1-51, TD 4480.

TEXAS DISTRICT 2—GAS FIELD EXTENSION

Bee County, Blanconia field. Coates, Kirkpatrick & Whitaker's John J. O'Brien 1, Edward & Michael Quirk Survey, 1-mile west extension, flowed 8-million from Frio sand, Oligocene 4046-4058 feet, open, completed 5-6-51, TD 5120.

Victoria County, Cologne field. Fidelity Oil & Royalty Company's Mettie Johnson 2, J. M. Cobarrubias Survey, ½-mile northeast extension, no gauge from Catahoula sand, Oligocene 2851-2861 feet, completed 3-25-51, TD 5032.

TEXAS DISTRICT 3—NEW OIL PAY

Harris County, Rankin field. Sun Oil Company's K. Tharp 2, Frederich H. Rankin Survey, flowed 101 barrels from 8703-8716 feet, 37.3-gravity, 8/64-inch, completed 5-6-51, TD 8953.

TEXAS DISTRICT 3—NEW DISTILLATE FIELDS

Colorado County, "Tait" field. Superior's Mathilda Tait 1-D, John Byrne Survey, flowed 30 barrels and 1.9-million from 10,715-10,744 feet, 49.2-gravity, ¼-inch, completed 5-4-51, TD 12,775.

Liberty County. General Crude Oil Company's Esperson C-2, George Pace Survey, flowed 57 barrels and 4.2-million from 8957-8961 feet, ⅝-inch, completed 4-22-51, TD 10,190.

TEXAS DISTRICT 3—NEW GAS FIELD

Matagorda County. Brazos Oil & Gas Company's State of Texas 2-X-A, Matagorda Bay, State Tract 195, flowed 1.7-

Type "XV" (Extra Volume) King Swivels

For Circulating Large Fluid Volumes

Be Sure IT'S A KING *Be Safe*

Type "XV" King Swivels are designed specifically for drilling conditions where the circulation of greater quantities of drilling mud is required than can be handled by conventional models of small swivels.

In addition to oversize watercourses, King Type "XV" Swivels provide many exclusive features that make them the first choice everywhere for Water Well Drilling, Geophysical Drilling, Working Over, Drilling Shallow Oil Wells, Core Drilling, Drilling in and Coring with Reverse Circulation.

Check these outstanding advantages you get with King Type "XV" Swivels:

- OVERSIZE WATER COURSES assure Large Fluid Volume.
- MOULDED RUBBER PACKINGS ELIMINATE the stuffing boxes.
- HARDENED WEAR-BUSHINGS eliminate the washpipes.
- THE PACKING AND WEAR-BUSHINGS can be renewed within a very few minutes without removing any other part from the swivels.
- ANGULAR-CONTACT BALL BEARINGS provide ample thrust capacity and insure radial stability.
- ALLOY STEEL CONSTRUCTION assures safety with minimum weight.
- SHORT, COMPACT DESIGN requires less room in the derrick.
- STREAMLINED—no projections to "hang up."
- CLOSED HOUSING PROTECTS THE BEARINGS.
- LUBRICATION, of BEARINGS, is by means of a grease gun.

This swivel fulfills a long felt need of the well drilling fraternity.

See your latest Composite Catalog for other King Oil Tool products.

KING OIL TOOLS

210 TERMINAL STREET PHONE OS 3-3421

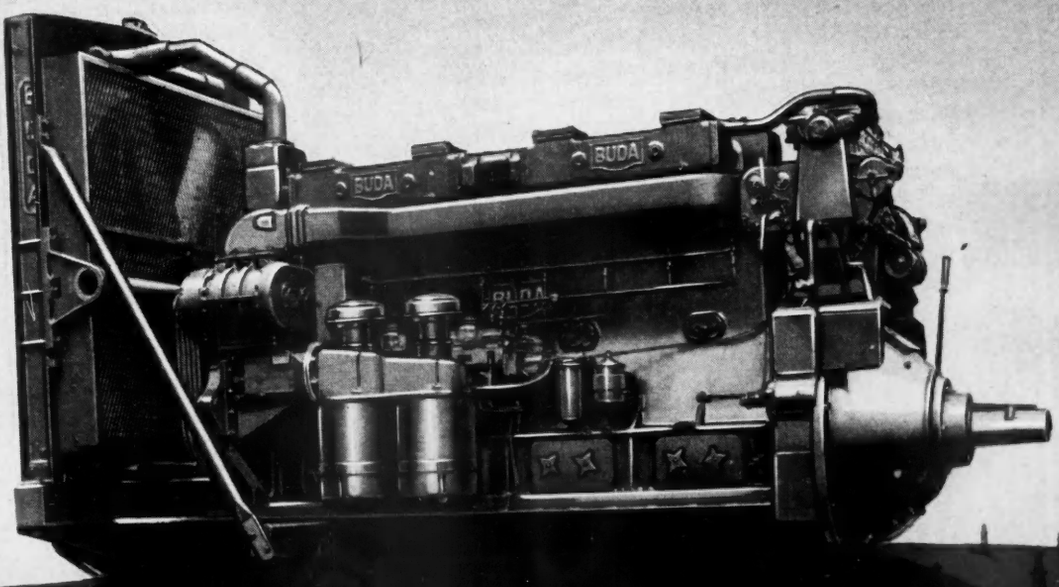
HOUSTON 20, TEXAS

EXPORT: R. S. STOKVIS & SONS, INC.

17 BATTERY PLACE, NEW YORK 4, N. Y.

OVERSHADOWS THEM ALL-

BUDA "2505" OILFIELD ENGINES

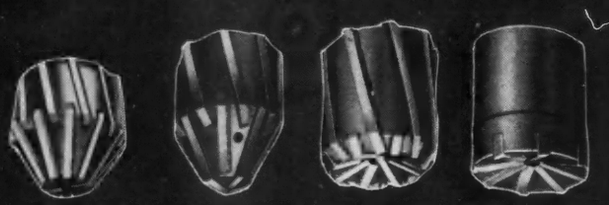


BUDA

Oilfield Distributors are located in ... Los Angeles • Houston • Oklahoma City • Seminole • Wichita Falls • Shreveport • Bakersfield • Tinsley • Pampa • Great Bend ... Beach • Kilgore • Mt. Carmel, Ill. • ... • Casper • Lafayette • Artesia • Denver • Ulysses • Brookhaven • New York City (Export) and in Canada at Calgary and Edmonton

KINZBACH Whipstocks and Mills-FIRST with oilmen for 24 years

Leading oil operators the world over use Kinzbach Whipstocks for side-tracking, straightening and directional drilling operations. They can be set at any depth, requiring no support for the bottom. Positive setting slips prevent slipping or turning in hole. They can be oriented to mill out in any direction. Patented hinge arrangement assures that top of Whipstock will lie close against pipe walls at all times, permitting easy passage of drilling tools. Setting trigger always locates whipstock between couplings so window will be within one joint. Available in all popular sizes of casing.



Type "A" Mill Type "D" Mill Type "H" Mill Type "I" Mill

Carefully heat-treated high-speed tool steel inserts from the cutting blades in Kinzbach Milling Tools. These inserts, set at most efficient cutting angles in properly shaped, high quality steel bodies provide unequalled cutting action and a uniform depth of cut.

KINZBACH TOOL CO., INC.
P. O. BOX 277 • HOUSTON, TEXAS

KINZBACH TOOL CO INC

Export Office:
74 Trinity Place,
New York, N. Y.

million from 2655-2685 feet, ¼-inch, completed 5-9-51, TD 6504.

TEXAS DISTRICT 3—GAS FIELD EXTENSION

Wharton County, Spanish Camp field. Earl T. Mackey's P. V. Chumchal 1, S. F. Austin Survey, ½-mile northeast extension, flowed 0.8-million from Catahoula sand, Oligocene 2956-2984 feet, 3/16-inch, completed 5-10-51, TD 3312.

TEXAS DISTRICT 4—NEW OIL FIELDS

Aransas County, Fulton Beach, West field. Sun's Copano Bay State Tract 76-1, Copano Bay State Tract 76, flowed 171 barrels from 7127-7131 feet, 41-gravity, ⅛-inch, completed 5-7-51, TD 7443.

Unnamed field. Phillips Petroleum Company's Copano Bay State Tract 67-9, Copano Bay State Tract 67, flowed 362 barrels from Frio sand, Oligocene 6660-6670 feet, 42.5-gravity, 3/16-inch, completed 5-9-51, TD 8050.

San Patricio County, "Roots" field. Rock Hill Oil Company's W. L. Roots 1, Section 24, 4th Addition, Taft Farm Lands, flowed 86 barrels from Frio sand, Oligocene 6043-6046 feet, 35.9-gravity, 9/64-inch, completed 4-28-51, TD 7515.

Starr County. Sun's A. C. Jones-State 3, Antonio Garza Aceveda Survey, flowed 131 barrels from 4657-4661 feet, 46.8-gravity, 5/32-inch, completed 5-3-51, TD 4668.

TEXAS DISTRICT 4—NEW OIL PAYS

Aransas County, Fulton Beach field. Union Oil Company's Copano State Tract 74-1, Copano Bay State Tract 74, flowed 77 barrels from 7166-7171 feet, 41-gravity, 7/32-inch, completed 4-24-51, TD 7197.

Hidalgo County, Cecil field. Taylor Refining Company's Garcia Land & Livestock Company 1, Porcion 42, flowed 38 barrels from 3974-3992 feet, 42-gravity, 7/64-inch, completed 4-18-51, TD 8208.

Hidalgo County, Los Torritos field. Taylor Refining & Mayfair Minerals Corporation's Boris Marinoff 1, Lot 85, Santa Ana Development Company Unit 3, Porcion 72, flowed 257 barrels from 5850-5856 feet, 49.4-gravity, 3/16-inch, completed 5-9-51, TD 9016.

San Patricio County, Rooke field. Plymouth Oil Company's E. H. Welder 5-F, Section 30, E. H. Welder Ranch Subdivision, flowed 107 barrels from Heep sand, Oligocene 5808-5811 feet, 42.3-gravity, 30-inch, completed 5-12-51, TD 9437.

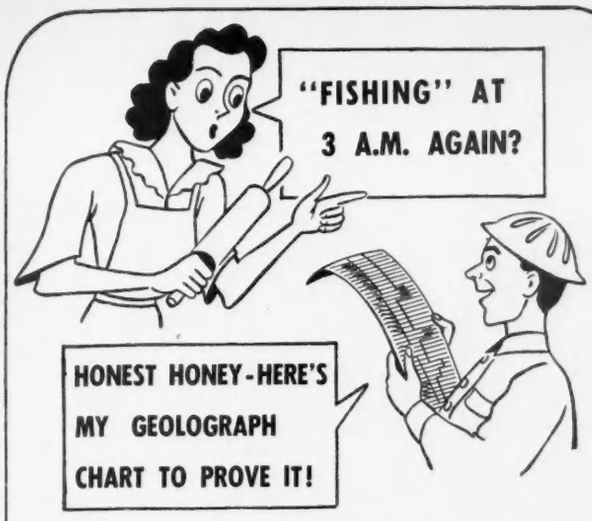
TEXAS DISTRICT 4—NEW DISTILLATE PAYS

Jim Wells County, Amargosa field. George W. Graham's Rescendez 1, J. Poitevent Survey, flowed 20 barrels and 6.2-million from 5968-5975 feet, 54-gravity, completed 4-22-51, TD 6595.

San Patricio County, Triple "A" field. J. S. & R. H. Abercrombie & Atlantic Refining Company's A. E. Nelson 2, Juan Garcia Survey, flowed 50 barrels and 8.5-million from 8730-8739 feet, 55-gravity, open, completed 4-19-51, TD 9287.

TEXAS DISTRICT 4—NEW GAS FIELD

Starr County. Bass & Vessel's Gregoria Garcia et al 1, Santa Cruz Grant, Sec-



You get the important details as *you drill*, when you use Geolograph Mechanical Well Logging Service! It's the *sure* way to keep up to the minute . . . to know where you are *all the time!* Complete enough for any job — yet reasonable enough for the small operator.

ABILENE, HOUSTON, ODESSA & WICHITA FALLS, TEX. • CASPER, WYO.
SHREVEPORT & BATON ROUGE, LA. • BAKERSFIELD, CALIF.

"TIME WILL TELL"

THE GEOLOGRAPH CO. INC.

P. O. Box 1291 Oklahoma City 1, Okla.

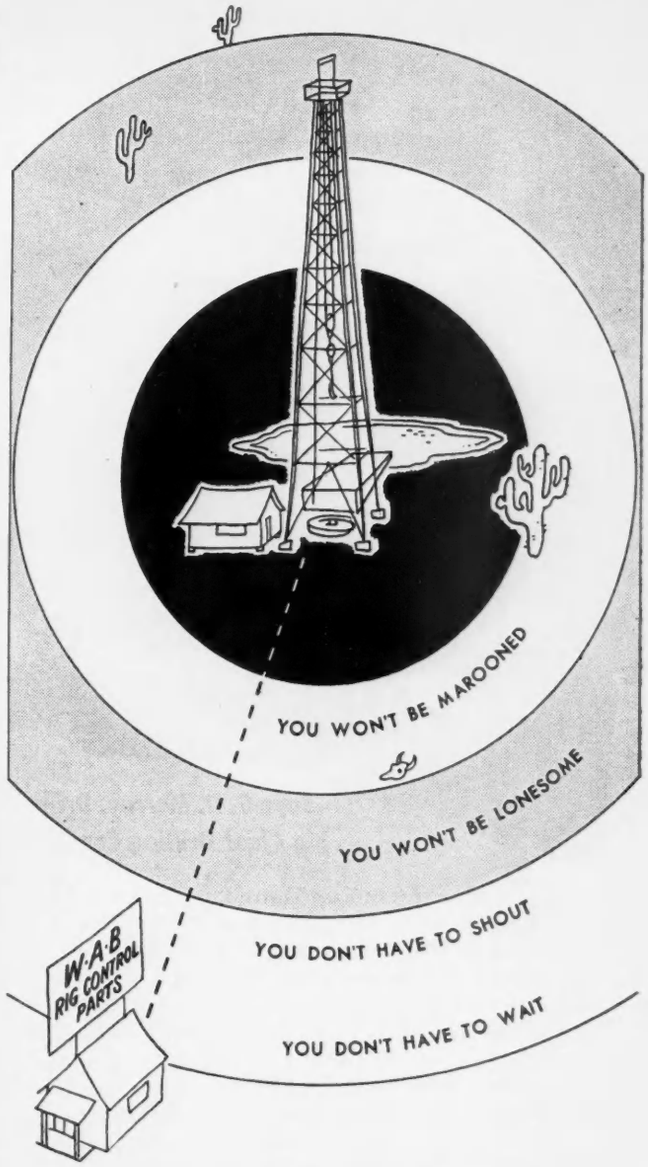
NOW YOU CAN EASILY TAKE ACCURATE WIRE LINE MEASUREMENTS

THE CAVINS DEPTHOMETER

will tell you where bottom is in little more time than it takes to make a trip with your bailer Gives you accurate depth in plain figures—compensates for raising and lowering tools when feeling for bottom. Strong, light-weight, easily used, and priced right Send today for illustrated folder.

THE CAVINS CO.

2853 Cherry Ave., Long Beach 6, California



We Aim to Stick Close to YOUR job

When you own a rig with W.A.B. Controls, you not only get tops in performance and dependability—but assurance of speedy maintenance service, too. Our Parts Stocks are spotted at convenient points . . . so you're never far from a source of supply, organized to serve you fast and well. Make a note of the address in your locality, so you can reach us at once in case of need.

WESTINGHOUSE
AIR BRAKE COMPANY
WILMERDING, PENNA.
INDUSTRIAL PRODUCTS DIVISION

Factory Branch: Emeryville, Calif. Distributors throughout the United States. Consult your Classified Directory. Distributed in Canada by: Canadian Westinghouse Co., Ltd., Hamilton, Ontario

"Our PIPER'S a paying proposition"

Says G. D. Murray, Drilling Superintendent Big Chief Drilling Company, Shreveport, La.

"Supervising rigs in East Texas, Louisiana and Mississippi keeps me on the go," says Mr. Murray. "I used to average 1200 miles a week by car which meant I spent most of my time driving.

"That's why I decided to fly. Took my first lesson last November and was amazed at how easy it was to learn. In the first six months I flew our company-owned Piper planes over 50,000 miles. Now I'm averaging better than 2000 miles a week in our new Piper Pacer and I've tripled the amount of time I can spend on the job at the rigs.

"The Pacer costs less to operate and maintain than a car and I'm averaging 135 miles per hour. Quite often I can land right beside a rig because the Pacer doesn't need much room. It would be hard to say how many times our Piper has paid for itself. It certainly is a paying proposition."

ON THE GO ALL THE TIME— *that's the Big Chief Drilling Company's versatile Piper Pacer. For men or materials the Pacer provides speedy, economical transportation. At left G. D. Murray (white shirt) prepares to fly drilling personnel to an emergency job in southern Mississippi.*

Price-wise, performance-wide, Piper planes are ideally suited for many companies in the oil business. Piper planes cost little more than a fine car, are easy to fly and economical to operate. Why not investigate how your company can profit by using a Piper just as the Big Chief Drilling Company does. Your nearest Piper dealer will be glad to demonstrate the fine new Piper planes and explain the new Piper "Learn-as-you-Travel" plan. For colorful literature write Piper Aircraft Corporation, Lock Haven, Pa., Dept. L-7.

PIPER AIRCRAFT CORP., LOCK HAVEN, PA.

tion 6-B, flowed 2.9-million from 4614-4650 feet, 56-gravity, open, completed 5-9-51, TD 6005.

TEXAS DISTRICT 4—GAS FIELD EXTENSIONS

Hidalgo County, McAllen field. Taylor Refining & Mayfairs' Carl Evans 1, J. C. Kelly Subdivision, ¾-mile south-southeast extension, flowed 21-million from 8657-8700 feet, open, completed 4-22-51, TD 12,460.

Jim Wells County, Henshaw field. Rand Morgan's fee 2-H, Section 1, Ragland Farm Tracts, ¾-mile southwest extension, flowed 4.3-million from 4263-4271 feet, open, completed 4-24-51, TD 4328.

TEXAS DISTRICT 5—NEW OIL FIELDS

Grayson County. L. O. McMillan's O. B. Rich 1, R. H. Armstrong Survey, flowed 415 barrels from Oil Creek sand, Pennsylvanian 8233-8235 feet, 41-gravity, 3/16-inch, completed 5-2-51, TD 8237.

Grayson County, Snuggs & Neil's Quinton Little 1, William Allen Survey, flowed 157 barrels from Upper Pennsylvania sand, Pennsylvanian 3619-3629 feet, 37.4 gravity, 10/64-inch, completed 5-16-51, TD 3629.

TEXAS DISTRICT 5—OIL FIELD EXTENSION

Grayson County, Sandusky-Oil Creek field. Lyons, Prentiss & McCord's G. C. Brown 1, E. Hartzog Survey, ¾-mile southeast extension, flowed 218 barrels from Oil Creek sand, Pennsylvanian 7101-7107 feet, 41.3-gravity, 9/64-inch, completed 5-29-51, TD 7115.

TEXAS DISTRICT 5—NEW DISTILLATE FIELD

Rains County. R. J. Caraway's H. L. Puckett 1, J. R. Dyer Survey, flowed 203 barrels and 45-million from Smackover lime, Jurassic 11,958-12,126 feet, 55.8-gravity, ⅜-inch, completed 5-7-51, TD 12,602.

TEXAS DISTRICT 7-C—NEW OIL FIELDS

Reagan County, "Weddell" field. Blackwood & Nichols' Weddell 1, Section 19, Block E, HE&WT Survey, flowed 209 barrels from Spraberry sand, Permian 7145-7185 feet, 41-gravity, ⅜-inch, completed 5-24-51, TD 11548.

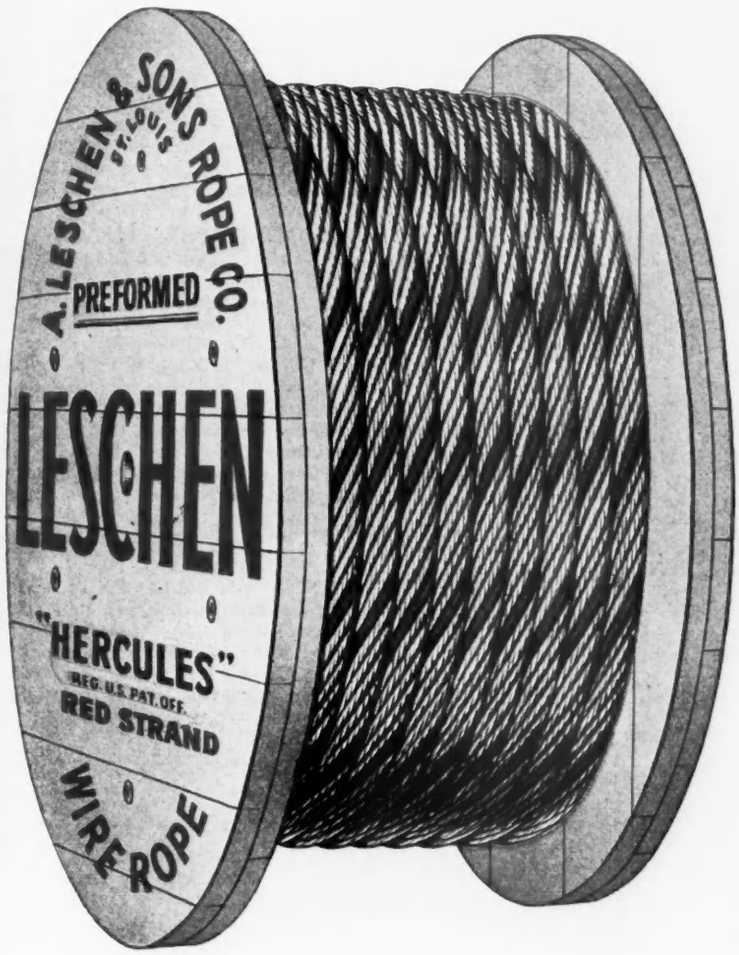
Un-named field. Texas Crude Company's L. C. Proctor 1, Section 40, Block 37, T-5-S, T&P Survey, pumped 71 barrels from Spraberry sand, Permian 6915-7128 feet, 36.9-gravity, completed 5-24-51, TD 7128.

Runnels County. Russell Hayes & Ed Watt's William Fowler, Jr. 1, Section 150, ETRR Survey, pumped 36 barrels from Serratt sand, Pennsylvanian 2349-2352 feet, 46-gravity, completed 5-15-51, TD 2352.

Upton County, "Wilshire-Ellenburger" field. Sinclair Oil & Gas Company's McElroy Ranch 1, Section 129, Block D, CCSE&RGNG Survey, flowed 288 barrels from Pennsylvania sand, Pennsylvanian 9365-12,438, 49.9-gravity, 21/64-inch, and flowed 1681 barrels from Ellenburger lime, Ordovician 12,306-12,406 feet, 53.6-gravity, open, completed 4-30-51, TD 12,438.

Un-named field. Gustave Ring's F. F. Elkin 1, Section 19, Block 37, T-5-S, T&P Survey, flowed 125 barrels from Spraberry sand, Permian 7042-7122 feet, 38-gravity, 22/64-inch, completed 4-28-51, TD 7122.

The tougher the job...



the greater the need for

"HERCULES"
REG. U.S. PAT. OFF.
RED-STRAND
WIRE ROPE

Its fitness for tough work has been proved by many years of actual on-the-job performance. Strength, toughness, flexibility, and durability . . . *in correct balance* . . . provide safe, dependable, and economical wire rope service.

"HERCULES" (Red-Strand) Wire Rope was originated by Leschen in 1886 to meet the rope requirements of bigger, better material handling equipment—and tough jobs have been its proving grounds ever since.

Let the Red-Strand be *your* wire rope guide. You will find its reputation justly earned.

Round Strand or Flattened Strand – Preformed or Non-Preformed – Wire Rope Core or Fiber Core. Let us help you select the *right* rope for your job.

We Invite Your Inquiries

MADE ONLY BY

A. LESCHEN & SONS ROPE CO. 5909 KENNERLY AVE. • ST. LOUIS 12, MO.

ESTABLISHED 1857

New York 6 · Chicago 7 · Birmingham 6 · Houston 3 · Denver 2 · Los Angeles 21 · San Francisco 7 · Portland 9 · Seattle 4

Upton County. Paul F. Barnhart's V. P. Tippett 1, Section 46, Block 38, T-5-S, T&P Survey, flowed 343 barrels from Spraberry sand, Permian 7170-7233 feet, 37.8-gravity, 22/64-inch, completed 5-14-51, TD 7233.

TEXAS DISTRICT 7-C—NEW DISTILLATE PAY

Crockett County, Un-named field. Cities Service Oil Company's Owens E-1, Section 14, Block GG, GC&SF Survey, flowed 110 barrels and 50-million from Canyon sand, Pennsylvanian 6185-6250 feet, 63.2-gravity, 19/64-inch, completed 4-18-51. TD 6733.

TEXAS DISTRICT 7-C—NEW GAS FIELD

Runnels County. Ted Weiner & Anton Oil Corporation's T. V. Jennings 2, Section 332, H&TC Survey, Evans Morris Survey, flowed 4-million from Caddo conglomerate, Pennsylvanian 4452-4457 feet, open, completed 5-10-51, TD 4568.

TEXAS DISTRICT 8—NEW OIL FIELDS

Borden County. Rowan Oil Company's C. H. Garner 1, Section 80, Block 20, Lavaca Navigation Company Survey, pumped 133 barrels from Clear Fork sand, Permian 4242-4274 feet, 27-gravity, completed 5-13-51, TD 7520.

Crane County. Placid's, Callery & Hurt and Byrd-Frost Incorporated's E. A. Culbertson 1, Section 16, Block 6, H&TC Survey, pumped 83 barrels from Clear Fork lime, Permian 3082-3315 feet, 41.2-gravity, completed 4-24-51, TD 3315.

Dawson County. Amerada Petroleum Corporation's D. L. Adcock 1, Section 106, Block 34, T-7-N, T&P Survey, flowed 883 barrels from Siluro-Devonian lime, 10,605-10,615 feet, 41-gravity, ½-inch, completed 5-8-51, TD 10,888.

Un-named field. James H. Snowden et al's Carrie S. Dean 1-30, Section 30, Block 1, J. Pointevent Survey, pumped 160 barrels from Spraberry sand, Permian 7288-7298 feet, 39.6-gravity, completed 5-3-51, TD 8634.

Midland County. Magnolia's Sam R. Preston 1, Section 41, Block 37, T-4-S, T&P Survey, pumped 109 barrels from Spraberry sand, Permian 7098-7148 feet, 38.2-gravity, completed 5-18-51, TD 7310.

Midkiff-Spraberry field. Sinclair's Lillie Midkiff 1-A, Section 2, Block 38, T-5-S, T&P Survey, flowed 325 barrels from Spraberry sand, Permian 7190-7226 feet, 36.1-gravity, ¾-inch, completed 5-19-51, TD 7232.

Midland County, Parks-Pennsylvanian field. The Texas Company's Clarence Scharbauer et al 2, NCT-1-A, Section 19, Block 40, T-2-S, T&P Survey, flowed 435 barrels from Pennsylvania sand, Pennsylvanian 10,505-10,750 feet, 44-gravity, ⅜-inch, completed 4-28-51, TD 10,775.

TEXAS DISTRICT 8—NEW OIL PAY

Scurry County, Cogdell field. The Texas Company's P. L. Fuller 156-F, Section 652, Block 97, H&TC Survey, flowed 630 barrels from Fuller sand, Permian 5149-5169 feet, 43.8-gravity, 24/64-inch, completed 5-29-51, TD 5350.

TEXAS DISTRICT 8—OIL FIELD EXTENSIONS

Glasscock County, Tex-Harvey field. Amerada's Bertie Boone 1, Section 45, Block 36, T-2-S, T&P Survey, 1½-mile east extension, pumped 108 barrels from Spraberry sand, Permian 6861-6990 feet, 35.8-gravity, completed 5-4-51. TD 7900.

Tex-Harvey field. Amerada's Eula A. Woody 1, Section 10, Block 36, T-3-S, T&P Survey, 1½-mile east extension, pumped 100 barrels from Spraberry sand, Permian 6804-6823 feet, 34.9-gravity, completed 5-4-51, TD 8390.

TEXAS DISTRICT 8—NEW GAS FIELD

Pecos County. G. H. Vaughn's Iowa Realty Trust 1, Section 27, Block 10, G&GN Survey, flowed 3.3-million from McKee sand, Ordovician 6780-6790 feet, ⅜-inch, completed 5-11-51, TD 8223.

TEXAS DISTRICT 10—NEW OIL FIELD

Gray County. The Texas Company's C. S. McGarraugh B-1, Section 139, Block 13, T&NO Survey, flowed 264 barrels from Atoka sand, Pennsylvanian 8473-8520 feet, 48.7-gravity, TD 8540.

WYOMING—NEW FIELDS

Fremont County. Sinclair's Indian 1, NE NW SE 4-2n-1w, swabbed 60 barrels and 81 barrels water from Phosphoria lime, Pennsylvanian 6042-6065 feet, 21.5-gravity, TD 6390.

Niobrara County. Bullock & Tullis' Schaffer 2, SE SW 30-35n-65w, pumped 8 barrels from Muddy sand, Upper Cretaceous 1474-1502 feet, TD 1502.

Sublette County, "Tip Top" field. General Petroleum Corporation's Government 4x-12, SW SW NW 12-28n-114w, flowed 147 barrels from Nugget sand, Jurassic 9682-9714 feet, 55.5-gravity, open, completed 5-17-51, TD 9808.

WYOMING—OIL FIELD EXTENSION

Washakie County, Slick Creek field. General Petroleum's Government 22-2, SE NW NW 2-46n-92w, southeast extension, flowed 762 barrels from Phosphoria sand, Pennsylvanian 10,438-10,523 feet, 34.4-gravity, 7/8-inch, completed 5-28-51, TD 10,523.

Contour Mapping
Core and
Shot Hole Drilling
Electrical Surveys
and Interpretations

HORACE ADAMS
SUPERVISOR
12 YEARS EXPERIENCE

NORTHWESTERN
Exploration Drilling
COMPANY

P. O. BOX 1301 • MIDLAND, TEXAS

Harry S. Smith, Partner
C. W. Nugent, Partner
G. L. Nugent, Partner

The men and machines that made 'em ... know 'em best!

- Complete factory overhaul
- Double check magnaflux inspection
- Matched metal build-up
- Refinishing and repainting
- New life for old metal through heat treatment

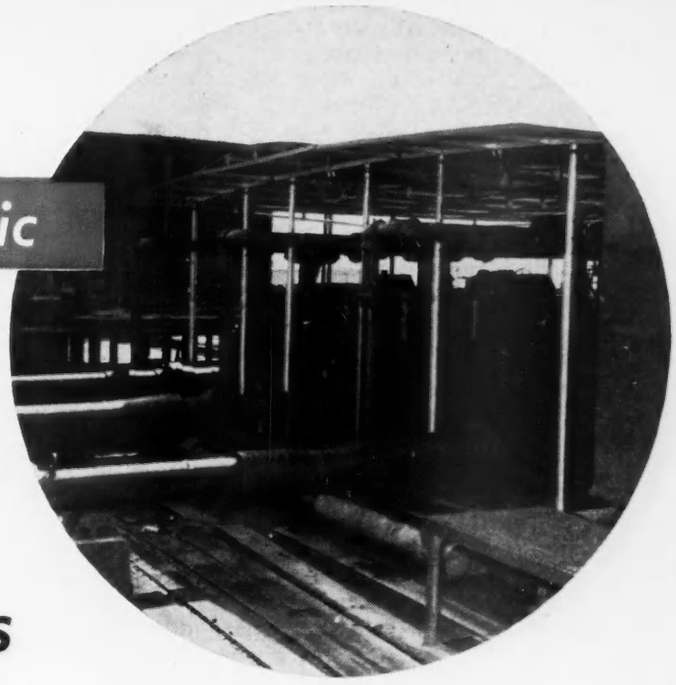
Byron Jackson Co.

MID-CONTINENT SERVICE: 6247 Navigation Blvd., Houston, Texas
Woodcrest 8321

PACIFIC COAST SERVICE / ROCKY MOUNTAIN SERVICE: 2301 E. Vernon Ave., Los Angeles 58, Calif.
Jefferson 6171

Contractors' Cost Clinic

No. 1



Unitized Mud Pumps Increase Flexibility

By A. W. SHAW
Gulf Coast Division Drilling Superintendent
Magnolia Petroleum Company

STEAM rigs can be removed from the possibility of approaching obscurity through the application of equipment unitization—a phenomenon encouraged by the coordinated effort of practical experience plus sound engineering. The monetary and time investment required to rigup steam tools can be slashed to an astounding degree in the field development of this principle.

The average drilling tool operator often believes the investment required for the unitization of steam equipment is not economically feasible. This initial investment may often seem prohibitive; however, if the operation is intelligently carried out by the application of coordinated practical experience and sound, basic engineering, an ultimate payout of the project may become more obvious. The operator who continues to utilize drilling equipment in a piece-meal fashion is immediately confronted with extended rigup periods and retarded flexibility of machinery application. By the token of this thought, I have always considered it to be good operating practice to unitize equipment in a manner conducive to rapid rigup practice and the efficient execution of tool assignments.

THIS ARTICLE, the first in a series covering the time-tested ideas of outstanding drilling-tool operators in the industry, describes the manner in which steam mud pumps can be assembled as compact, flexible and efficient units. The idea reduced the rigup period 80 percent and increased the operational flexibility of the equipment to an equivalent degree.

Some operators are of the opinion that the unitization of steam tools is a particularly unwise venture due to the often mentioned, and more frequently unqualified, statement that steam tools are on their way out. It is the author's contention that steam tools are being classed as of secondary importance because of definite neglect, on the part of the operator, to maintain steam rig design abreast of modern ideas. For this reason, the steam rig is often represented by a group of disorganized equipment not capable of making complete flexibility available in field operation.

An example of what may be done with the unitization of steam tools is well illustrated in Magnolia Petroleum Company's version of fabricated steel mud pump units. Why unitize steam mud pumps? The answer is quite simple. Prior to the unitization of these tools, it was necessary for five men, with the assistance of a truck, to invest eight hours toward the process of rigging-up three 20-inch mud pumps. Even after the pumps had been placed in service, optimum performance characteristics were not available. With the unitization of this equipment, it is now possible for two men, with the part-time assistance of a truck, to prepare three pumps for immediate operation in four hours. Thus, a requirement of 40 man-hours to rig the old style unit is contrasted to an investment of eight man-hours to place the unitized pumps in service. This item of time saved may seem rather insignificant. However, the fact remains that an idle rig represents 100 percent overhead, whereas the assembled operating unit is in a position to better compensate the owner. By cutting down the manpower requirements for the rigging-up of mud pumps, it is possible to

concentrate more heavily on the assembling of the remaining equipment on location. A few of the other advantages offered by the unitized steam pumps encompass increased maneuverability and more flexible operating facilities when wide and varied demands are placed on the system.

Unit Base and Piping Detail

Construction of these mud pump units has been held to maximum simplicity. The base skids are constructed of ten-inch, 49-pound I beams with eight-inch, 31-pound cross members welded in a position to assure complete anchorage and support of the mud pumps. The end sections of the skids are rolled to facilitate easier handling in transport and spotting on location. Steel plate saddles are welded on the skid beam for the secure placement of the mud and steam lines. The lines may be clamped in place or allowed to remain free to permit more elastic rigup.

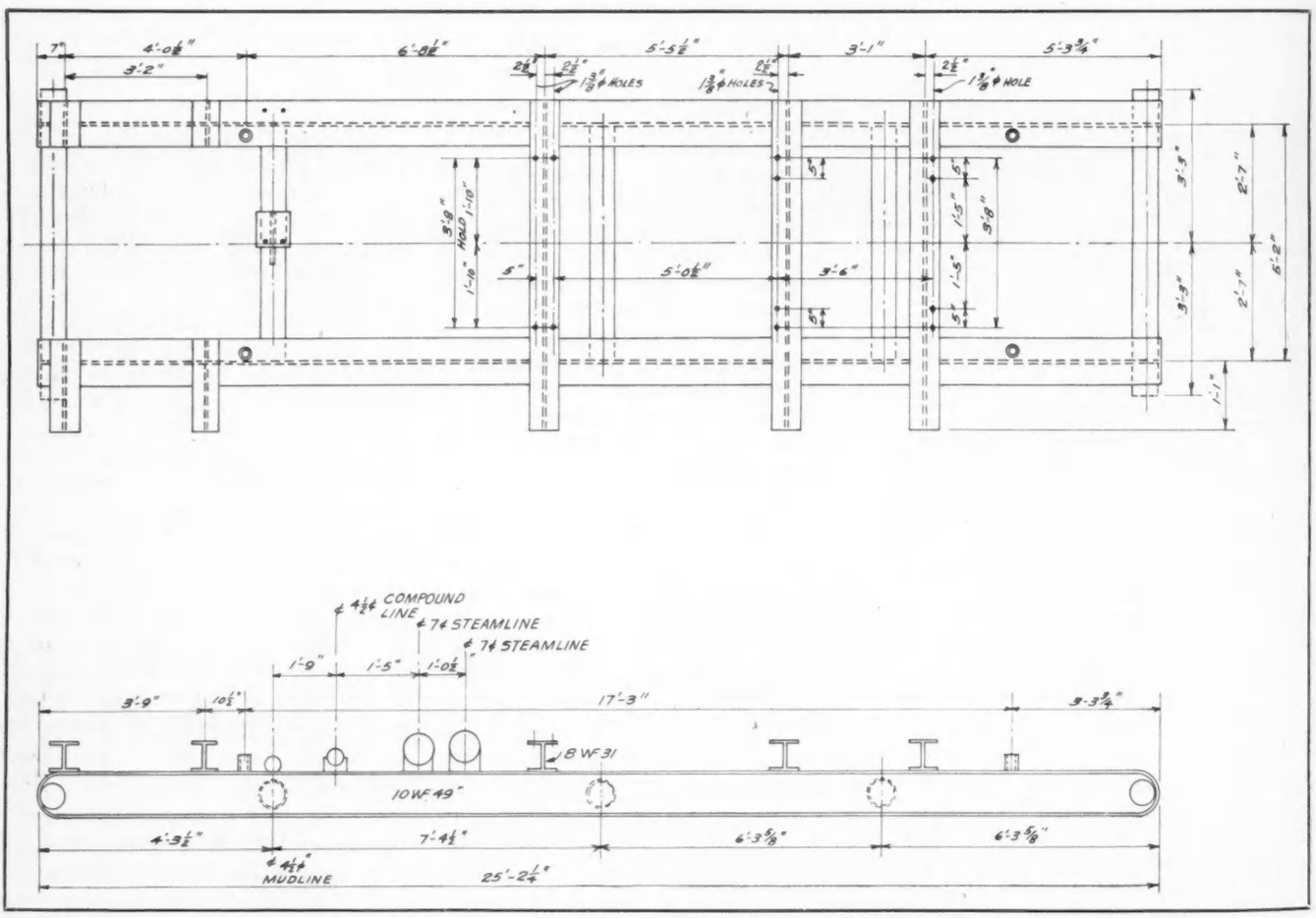
Actual movement of the line is governed by the plate saddle supports. Provisions have been made for the installation of 4½-inch mud lines, 4½-inch compound lines, 7-inch exhaust lines and a 7-inch steam supply line at the steam end of the mud pump. Additional reinforcement of the base is afforded through the welding of six-inch drill-pipe aligning braces between the I-beam runners. Four 3-inch collar type sleeves are installed on top of the runners to house the 2½-inch pipe roof supports.

Assembling Units

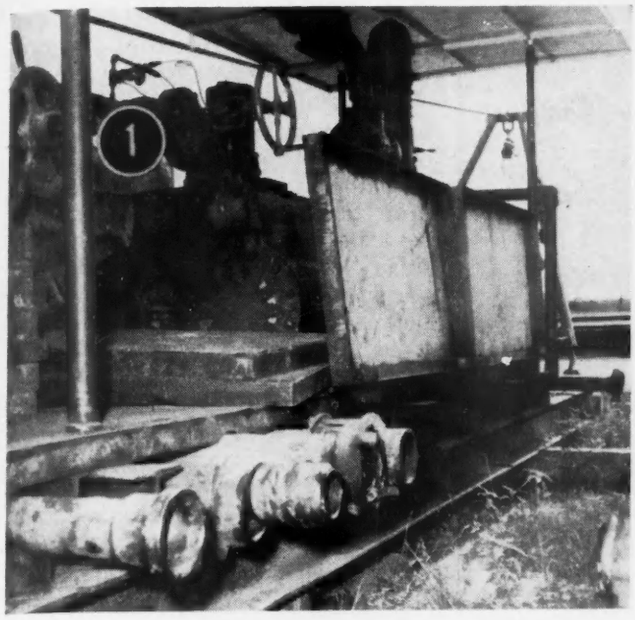
Flexible, misaligning unions are attached to the mud lines to make possible a more rapid rigup of the unit. The steam carriers are supplied with sleeve-type couplings to compensate for any expansion. Actual assembling of these units merely requires the flanging of five unions between each of the three pumps. Coupling of the far unit, which is adjacent to the boilers, involves connecting the steam exhaust line to the stack blower, flanging-up the steam supply line from the generating plant, and tying-in the mud line to the hopper. The pump unit next to the rig is placed in service by connecting the stand-pipe, gun, and relief valve lines. Full sweep fittings are installed in the mud system to insure the development of minimum friction losses, an exception to this feature being the relief line where the occurrence of friction loss is not so detrimental to fluid travel.

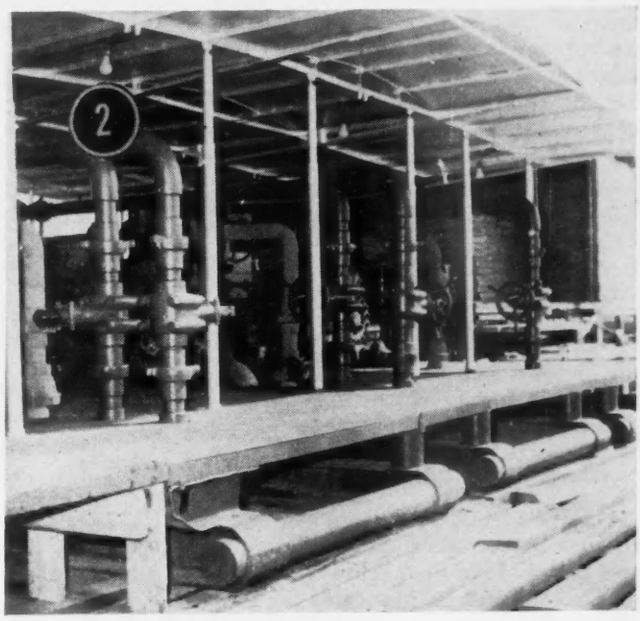
The ten-inch mud pump suctions are flanged direct to the lower section of the mud tanks. Misaligning unions are employed at the pump journals and a sleeve-type connection is located at the mud tank to permit wider tolerance for spotting equipment on location. The practice of flanging the suction to the lower portion of the mud tank provides a desirable fluid head which is conducive to more efficient pump operation. The suction line is spliced with a short section of rubber hose to afford ease of installation. Of course, the exposed end of the suction line, which projects into the mud tank, is equipped with strainers to block the entrance of foreign objects from entering the system.

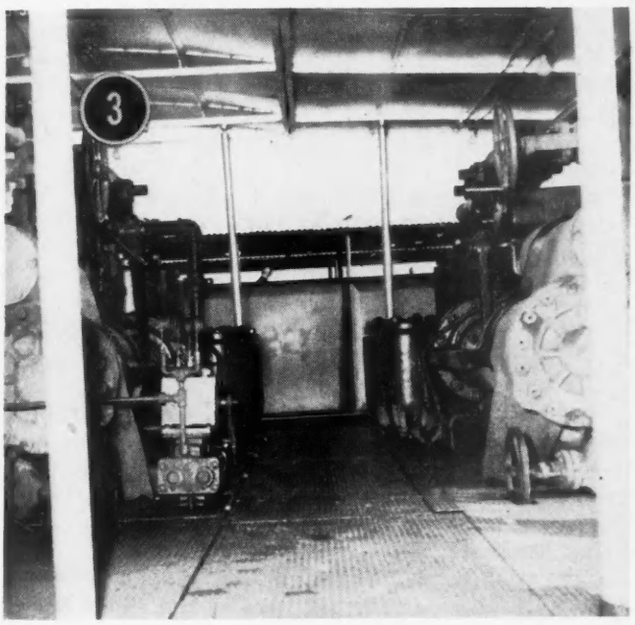
Even though the lines within the

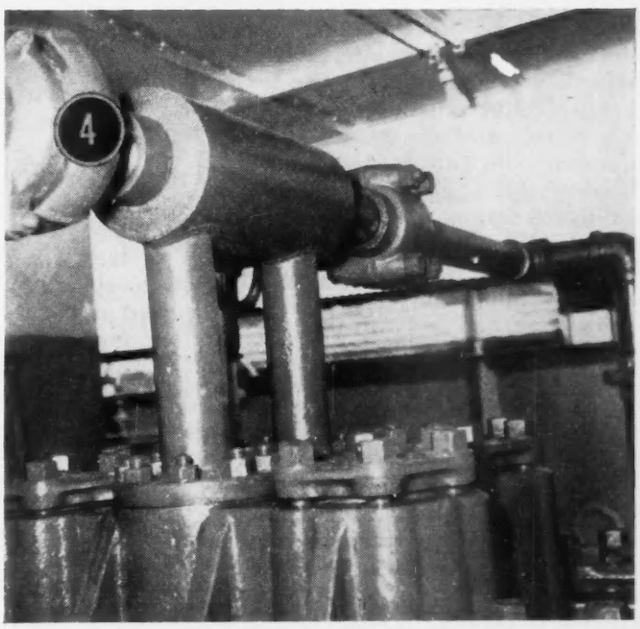


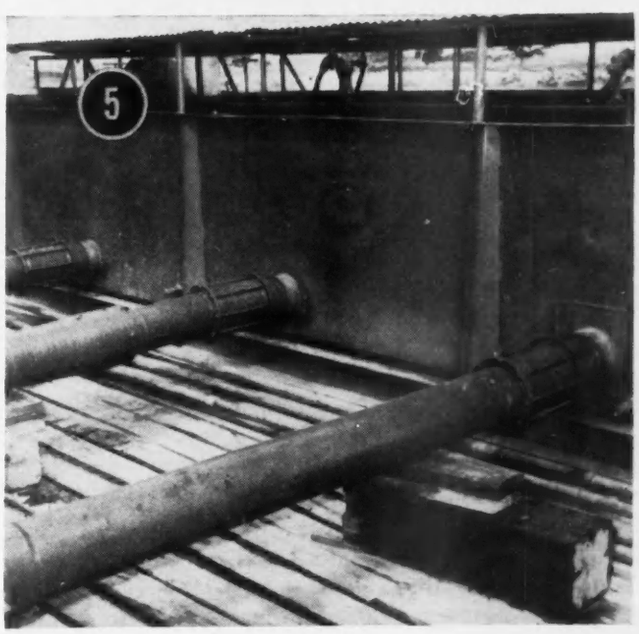
Structural detail of mud pump unit base illustrates placement of 10-inch I beam, 8-inch I beam cross members, and 6-inch drill pipe alignment braces. Steel plate saddles are welded to the skid beam for support of the mud and steam lines. Ends of the skid beams are rolled to facilitate easier handling in transport and spotting on location.











1. Rapid assemblage of the units is possible with the misaligning unions on the mud lines. Sleeve-type connections are installed on the steam lines ot allow for variable expansion factors. The folding floor section, adjacent to the pump bed, permits transport of the tools with the unit in place. Except for the floor plate bridging the line connections, all other segments of the floor plan remain intact. Dimension of the shelter may be reduced to highway specification by lowering the telescoping supports.
2. Mud lines are equipped with full sweep connections to reduce prevailing friction loss factors. The well-planned arrangements of mud and steam lines assists in a more rapid coordination of pump operation. The underside of the shelter is reinforced with 1½-inch angle iron. A lighting system is attached to the truss members of the 14-gauge sheet metal roof.
3. A 2 x 4 x 2 steam pump circulates lubricating media over the pump rods as an assist in the promotion of increased equipment service. Fabric hose directs the lube from a combination scavenger chamber and reservoir to each of the three mud pumps.
4. A non-baffled cell is substituted for the conventional air chamber to allow lowering the telescoping roof to the highway regulated height. Fabrication of the air chamber involves shaping a seven-inch casing nipple and attaching 3½-inch drill pipe feeder legs.
5. Suction lines are flanged at the pump journal and sleeved at the mud tank. The sleeve connections permit a wider tolerance for spotting mud tanks on location. Connecting into the lower portion of the mud tank makes available a fluid head conducive to more efficient pump operation.

unit are installed on a more permanent basis, a sufficient number of unions have been attached to expedite the completion of line or equipment repair. Complete unification of the mud pumps was achieved and space limitations met by the use of shop-fabricated air chambers. Actual construction of this shop-made air chamber involves shaping a seven-inch casing nipple equipped with 3½-inch drill pipe feeder legs. Represented by a simple, non-baffled cell, this air chamber has well served the purpose of permitting the installation of low, telescoping roof structures.

Hinged, Non-Skid Floor Plates

The first mud pump units constructed by Magnolia included plate steel in the floor plan. However, the more recent plan incorporates the installation of nonskid, expanded metal flooring. This alteration permits more convenient and rapid cleaning of the floor and provides a safer walking surface for rig personnel. The floor plate is reinforced with 1½-inch angle iron frames and the center unit is equipped with hinged floor sections on either side of the pump bed. It is possible to transport the middle unit with these particular sections of the floor attached. Necessary repairs to the mud pumps may be more conveniently carried out with the hinged walkways present. The remaining segments of the floor plan are framed sections of expanded metal which, because of their light weight, may be easily placed in their assigned space. Two of the floor sections, which are at the steam end of the mud pump, must be removed prior to rig transport. The floor plates have been tailored to closely fit around each pipe extending through the floor. In this manner, all safety hazards in the flooring plan have been virtually eliminated.

Forced Feed Lubrication of Pump Rods

Service records have indicated, without reservation, the proper lubrication of pump rods will result in the extended service of these essential parts. For this reason, a force feed system was incorporated in the center pump unit to facilitate a proper and permanent means of continuing this practice. Oil is circulated through the system by means of a 2 x 4 x 2 steam-actuated pump. The combination lube reservoir and settling chamber is installed immediately below the bed of the center mud pump. Lubricating media is distributed to the pump rods by means of a two-inch rubber covered fabric hose. A similar installation has been made to return the lubricant from the pump rod reservoir to the scavanger chamber and volume tank. The installation of this one pump makes available a sufficient fluid flow to effectively cool and lubricate the pump rods.

About the Author

ALBERT W. SHAW, Gulf Coast Division drilling superintendent for Magnolia Petroleum Company, joined the organization in 1918. Initially employed as a driller, he was promoted to toolpusher the following year. As a toolpusher, Shaw was responsible for the operation of Magnolia rigs in Oklahoma and Texas until 1932 when he was promoted to Gulf Coast Division drilling superintendent. Currently, there are 23 Magnolia rigs in the coastal area under the jurisdiction of Shaw. By the wide latitude of his drilling experience, he has observed the transition of machinery design from the day of the yellow-dog illuminated, one-cylinder steam engine rig to present-day tools capable of penetrating great depths.

Truss-Type, Welded Roof

A shelter over the mud pump units is not basically essential; however, if the rig is operating in the coastal area, it is certainly desirable to afford this protection against prevailing rains. The installation of this welded shelter does not present an additional problem in the actual movement of the tools. Constructed with 2½-inch telescoping supports, the roof may be lowered so it will rest on the mud pump during transport.

Structural features of the roof incorporate 1½-inch angle iron frames covered with 14-gauge sheet iron. The center pump unit is designed with a two-inch sheet metal overhang to provide a water proof seam at the junction of the number one and number three unit shelters. The welded, truss type supporting members of the assembly are constructed of 1½-inch angle iron.

Heavy duty porcelain insulators have been stationed at strategic points on the truss supports. Placement of the insulators is intended to insure their protection when the roof is lowered for transport. Heavy duty, rubber insulated electric wiring is threaded between insulators with conventional oil field type light sockets distributed along the line. Electric junction boxes are located at either end of the unit to assist in the rapid coupling of the lighting system.

For High-Pressure Operations

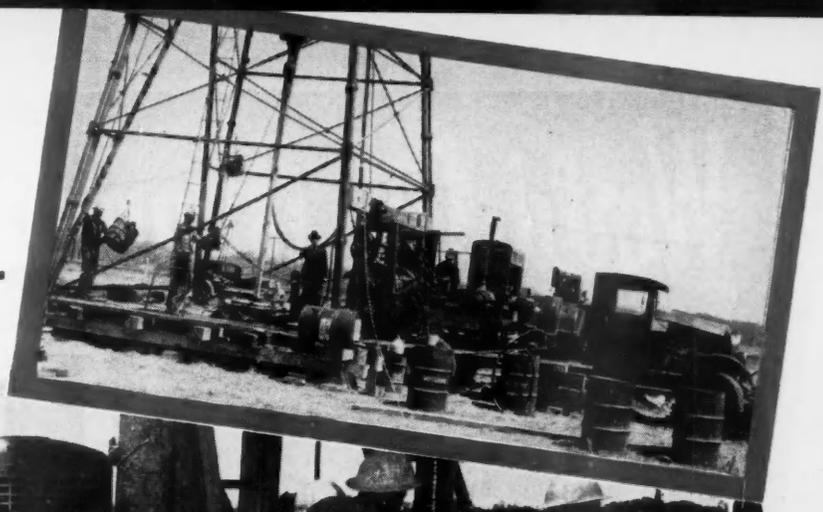
The mud pump unit, in its present form, is designed to assist in the drilling of high presure, difficult operations. With three 20-inch pumps available, one may always depend on having two of the units ready for compounding in case of an emergency The system is manifolded in a manner to permit circulation of the hole with two compounded pumps. The third pump may be in the process of repair, gunning the pits, mixing mud, or other services often demanded of the standby mud pump. An adaptation of this design is not necessarily restricted to large, high-pressure pumps. The same basic plan, with but few alterations, may be applied to the unitization of smaller mud pumps.

A possible point of contention is the initial expense involved in the fabrication of these unitized mud pumps; however, one may readily foresee a tangible payout of the units if the rig remains in continued service. In a final analysis of the matter, it is the writer's opinion that unless we attempt to maintain our steam rigs in accord with the rapid trend toward unitization and the streamlining of tool, the utility of steam equipment will become increasingly questionable. At the present time, the importance of the steam rig is somewhat overshadowed by the high cost of fuel and the lack of water in some areas. Again, there are other regions where the efficient and flexible application of the steam rig may not be easily approached by other type equipment. Hence, an important consideration which we must not overlook is the proper maintenance and unitization of steam tools in lieu of their versatile utility. The question of limited steam rig application will, of course, increase with the further neglect of unitization and adequate maintenance.

In 1932...

Wilson was There

Wilson was First...

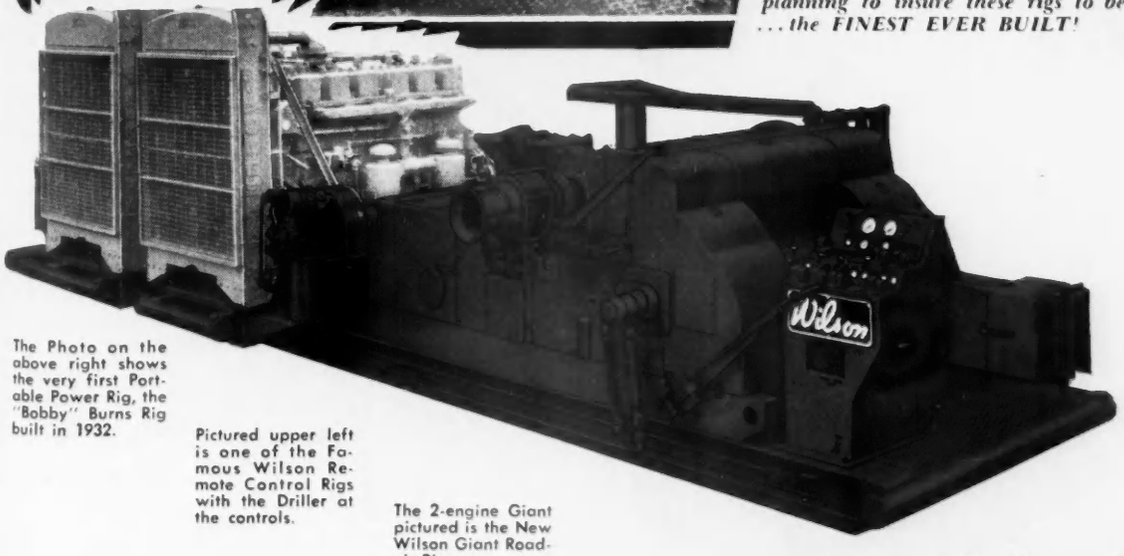


Still FIRST!

Wilson

World-Wide Pioneers and Leaders in RIGS and WINCHES

'Way back in 1932 they scoffed at the little Rig pictured above . . . but this was the forerunner of the ingenious Wilson Remote Control Rig and the massive 2 and 3 engine torque converter rigs. Drilling Experts have learned from experience . . . They recognize the Wilson trademark as a symbol of technically proved and field proven equipment. Into each Wilson Rig goes intensive engineering, Constant Progress and far-sighted planning to insure these rigs to be . . . the FINEST EVER BUILT!



The Photo on the above right shows the very first Portable Power Rig, the "Bobby" Burns Rig built in 1932.

Pictured upper left is one of the Famous Wilson Remote Control Rigs with the Driller at the controls.

The 2-engine Giant pictured is the New Wilson Giant Roadair Rig.

Compare Quality • Compare Prices

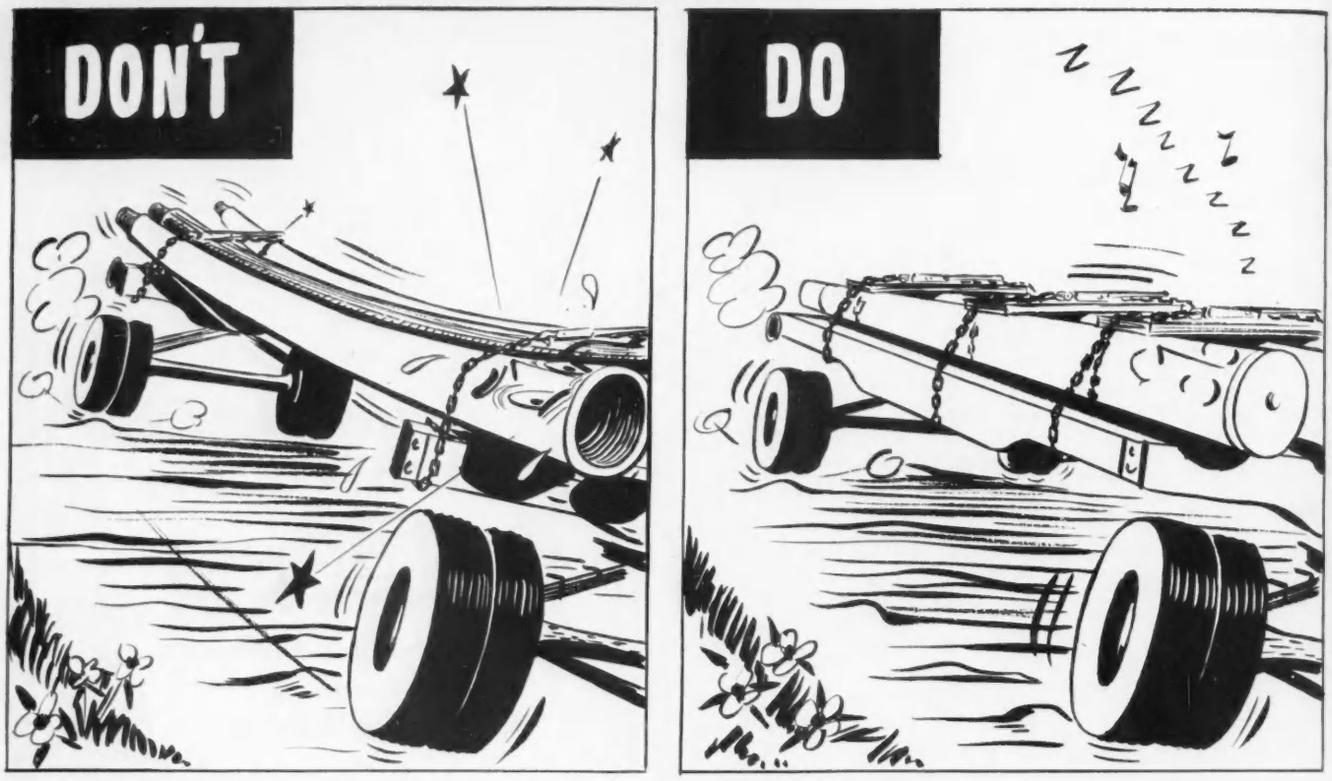
IT PAYS TO BUY A WILSON!

Wilson MANUFACTURING CO., Inc.

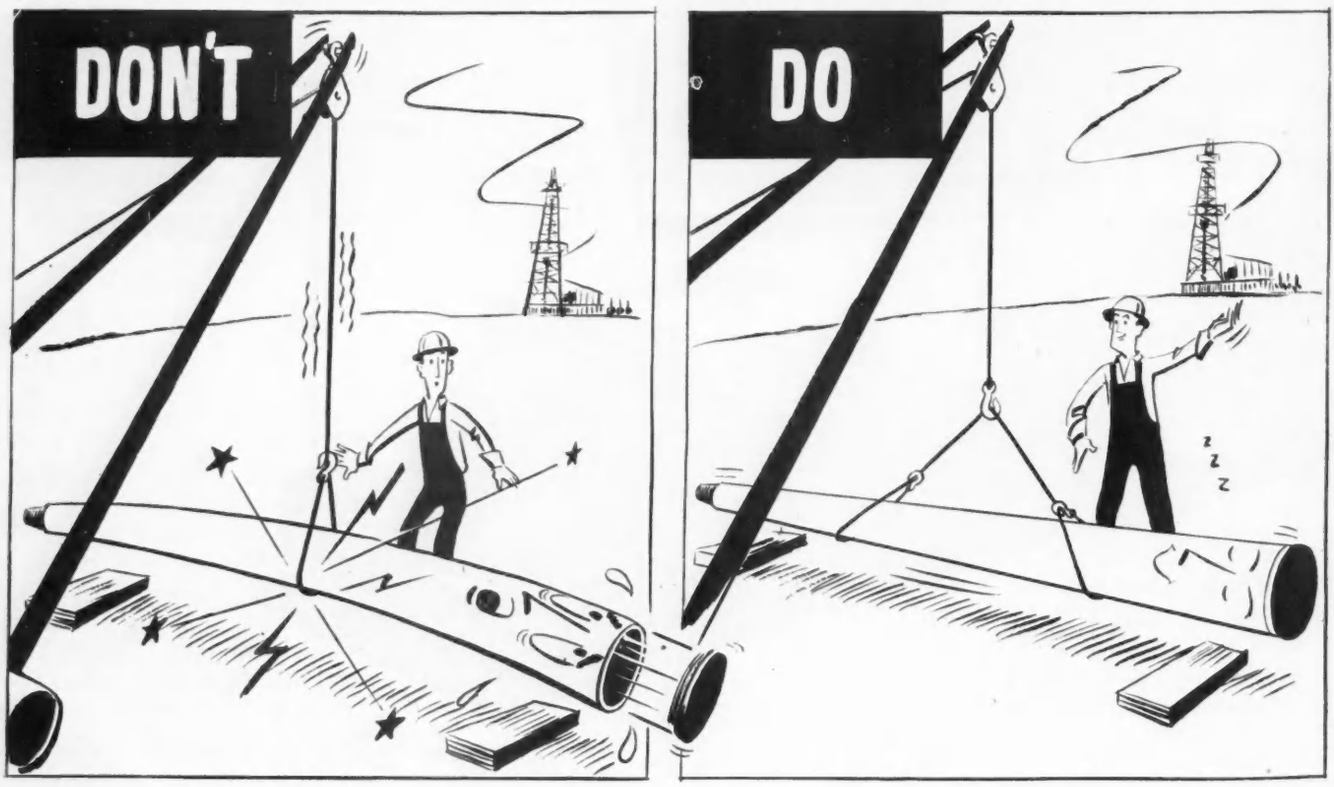
WICHITA FALLS, TEXAS

World Oil Graphics

DRILL COLLAR CARE



Heavy drill collars in transport must be well boomed and supported by float beds or timbers to avoid permanent kinks.

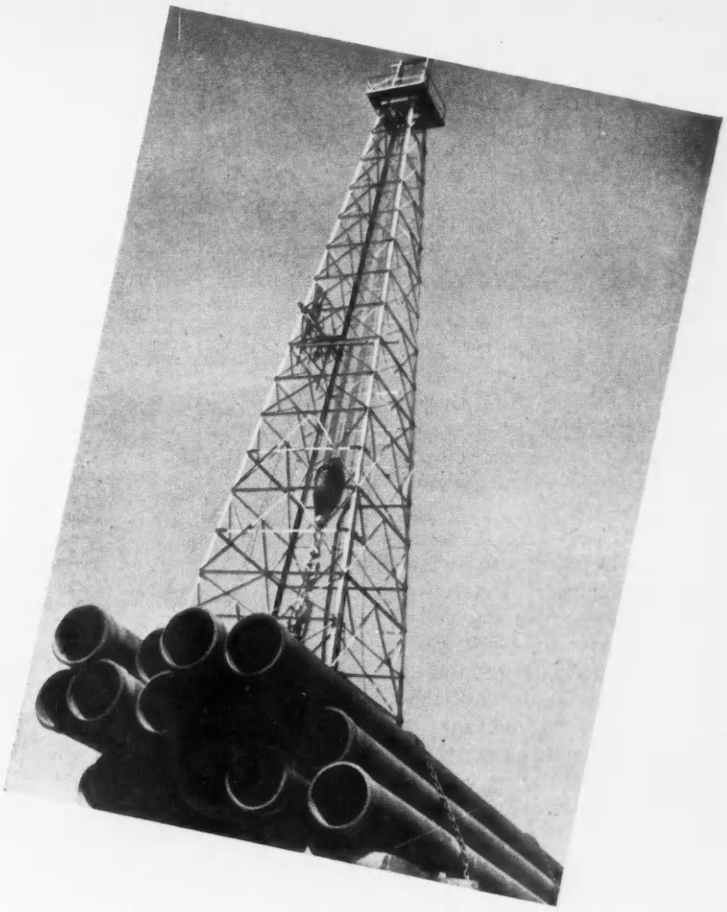


Single sling pickup may damage a collar. Use double slings, spaced five feet from each end, to prevent kinking.

A Review of

Casing String Design, Principles, and Practice

Part 1



By J. O. HILLS, Assistant Manager
Production Engineering and Equipment Section
General Petroleum Corporation

THIS ARTICLE relates the efficient designing of casing strings by the principle of basic engineering. Casing, one of the more critical items within the industry, must be efficiently utilized to promote increased materials conservation. Although several techniques of casing design evaluation have been developed through the years, this is one of the outstanding attempts to consolidate the more important and time proven mechanics of the problem within one paper. Field application of these data will undoubtedly expedite the formulation of better casing programs offering the advantage of tubular goods conservation, optimum safety features, and adequate well protection. This article is from a talk at the Spring Meeting, Pacific Coast District, Division of Production, American Petroleum Institute, Biltmore Hotel, Los Angeles, May 10-11.

CASING string design on an engineering basis becomes of increasing importance as well depth increases, and for very deep strings the weight of the casing must be held at a minimum not only to decrease cost but to provide safety in tension. However, proper design should not be restricted to deep wells, since it will result in economy and uniform safety in wells of any depth.

Conventional assumptions are often used to simplify design procedure even when the actual conditions can be evaluated with reasonable accuracy. For example, the effects of buoyancy often are not calculated and are considered to add to the safety factor. Such procedures tend to obscure the true margins of safety and make it difficult to determine the limits to which design can be carried. Lack of full knowledge of service conditions on casing strings makes it expedient to use some simplified assumptions, but the aim of design should be to do this as little as possible. A casing string is an expensive structure protecting a large investment and the cost of engineering time required for design is relatively small.

A properly designed casing string normally will consist of a number of sections of pipe, each with a different specification. It is essential that these sections be run in the well in proper order, since running even one joint in the wrong place can have disastrous consequences. Because of the difficulty of handling and the occurrence of errors, many operators in the past were reluctant to run these "combination" strings. Today, however, the combination string, and the necessary precautions in handling and running it, are generally considered routine. It is still desirable to restrict the sections to a reasonable number and to avoid joint changes

which make crossover joints necessary. It is also good practice to use at the top a joint or two of the heaviest weight pipe in the string. This tends to prevent starting tools in the hole which will not pass through the entire string, and also provides a thicker pipe wall where the landing slips are set.

Casing Strength Information

Necessary basic data on collapse, tension, and bursting strengths of American Petroleum Institute casing are available in API Bulletins 502[17] and 5A1.[18] The latter, though informational only, gives strengths for API threads on upset and specially treated ends.

All API performance data are given in terms of minimum strengths. Collapse and tension strengths are calculated by formulas derived from test results on full-sized casing specimens.[17] A percentage factor arrived at by statistical analysis of the test data is applied to the average values from the formulas to give the published minimums. Bursting strengths are derived from Barlow's formula using API minimum yield strengths with API minimum wall thicknesses.[18]

In their 1940 report[10] recommending the adoption of minimum strength values by the API, Wescott, Dunlop and Kemler expressed the hope and expectation that future test work and improvements in manufacture would result in adoption of higher minimum strength values. Unfortunately, such increases have not materialized, and the present API minimum strengths are those adopted in 1941.

Strength data for nonAPI pipe and threaded connections are obtainable from manufacturers' catalogs. Such data should be checked to determine if they are on the same basis as API strengths, although manufacturers are generally consistent in this respect.

Biaxial Stress

In applying casing strength data, the effect of combined axial and hoop stresses should be considered. This effect is important in casing string design chiefly because of the reduction of collapse strength due to the hanging weight of the pipe. Theoretical investigations of Holmquist and Nadai[7, 19] and experimental work of Edwards and Miller[20] indicate that the effect can be represented by the relationship shown in Figure 2. By examination of this figure it can be seen that tension always reduces the collapse strength of casing, while moderate degrees of compression will result in an increase.

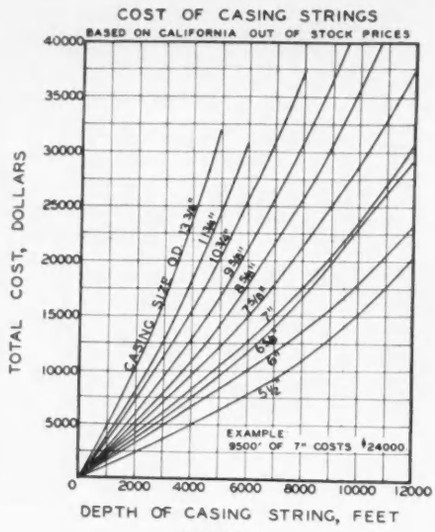

COST OF CASING STRINGS
BASED ON CALIFORNIA OUT OF STOCK PRICES
TOTAL COST, DOLLARS
DEPTH OF CASING STRING, FEET
CASING SIZE OD
EXAMPLE
9500' OF 7" COSTS $24000

FIGURE 1

Loads on Casing Strings and Their Application in Design

Three chief types of loading which casing strings must withstand are collapse, tension and bursting. The sources and characteristics of these loads and determination of their magnitude are illustrated and discussed below. However, there are other considerations which may be of equal or greater importance, and which are often limiting factors in the choice of casing.

These other considerations include wear, corrosion, vibration and pounding by drill pipe, effects of gun perforating, erosion, and general abuse by tools and equipment run in the well. They are not readily subject to calculation, and are met by applying the lessons of experience. This usually takes the form of specifying a minimum wall thickness or pipe weight for various casing sizes and service conditions. Tests by Oliphant and Farris[21] indicate that the stronger grades of casing resist splitting by gun perforating better than the weaker grades, and field experience seems ti confirm this. Individual opinions vary considerably on these matters, but the proper approach certainly is to consider each type of case separately, specifying minimum wall thickness or strength after reviewing experience data and studying the probable importance of these considerations.

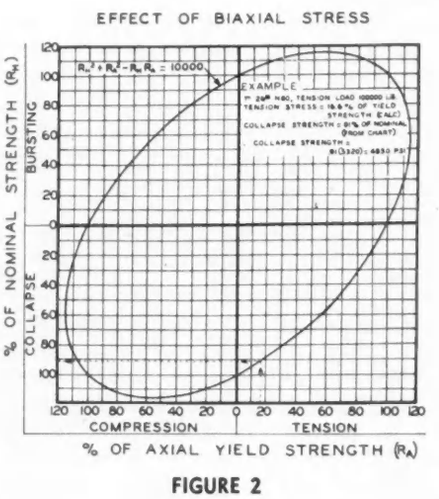


FIGURE 2

Collapse: Collapse loading on casing strings is caused by an external pressure higher than that inside the casing and is illustrated in Figure 3.

The most severe condition, and one commonly used for design purposes, is represented on Figure 3 by the mud pressure line and no internal pressure. This corresponds to a well emptied of fluid, zero pressure on the casinghead, and a full column of mud outside the casing. The casing collapse strength lines on Figure 3 are for a string of pipe strong enough to meet this condition with a margin of safety. The strength lines slope because of the effect of biaxial stress, and are shown only for lower sections where collapse is critical. Reduction of this maximum design pressure should be assumed only if one or more of the modifying conditions discussed below is almost a certainty.

Any internal pressure that will be maintained for the life of the well will allow a reduction of the collapse pressure to an amount indicated by the difference between internal pressure and mud pressure in Figure 3. In case of a protection string which will always be full of mud, little or no collapse loading will ever be applied.

Often the mud in which casing is run is known to be heavier than needed to balance the formation pressure. If it is certain that the mud and formation pressures will have equalized by the time the internal pressure is removed, formation pressure can be used as the external design pressure.

Cement placed around the bottom will give some protection against collapse and may justify a slightly reduced collapse safety factor. Also favoring a lower safety factor at bottom is the fact that the internal pressure is more likely to be maintained there than further up the string.

One fairly common well operation which can result in abnormally high collapse pressure is a squeeze job as illustrated in Figure 4. Because fluid cement in the drill pipe usually is

WOULD YOU RISK YOUR DRIVE TO SAVE A BALL?

Sometimes you may get a pretty fair drive by teeing off with an old ball to save a new one. And sometimes you get a pretty fair oil well even though you attempt to perforate the casing with out-moded methods. But the record of thousands of JET perforated wells shows that you best protect your well investment, and obtain increased productivity by perforating with Welex Jets. That is why more than 50% of all casing perforating done in the U. S. today is done by the JET process originated by Welex. Welex Jet Perforating gives you the economy of *positive penetration and known hole density* . . . with *no burr, no fracturing,* and *no debris* left in the well. Results cost less with Welex Jets. Call your nearest Welex Station for prompt service day or night.

ORIGINATORS OF Welex JET PERFORATING

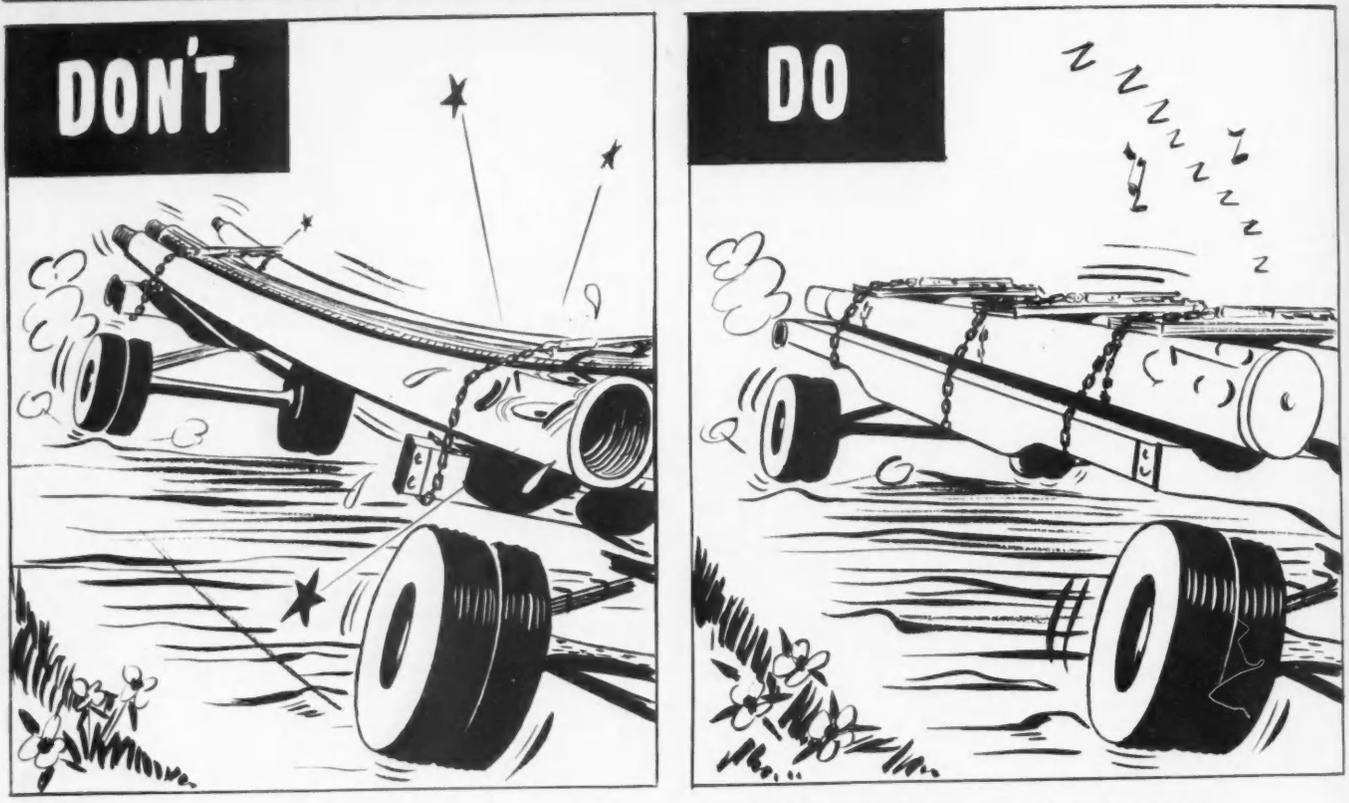
Welex

JET SERVICES INC.

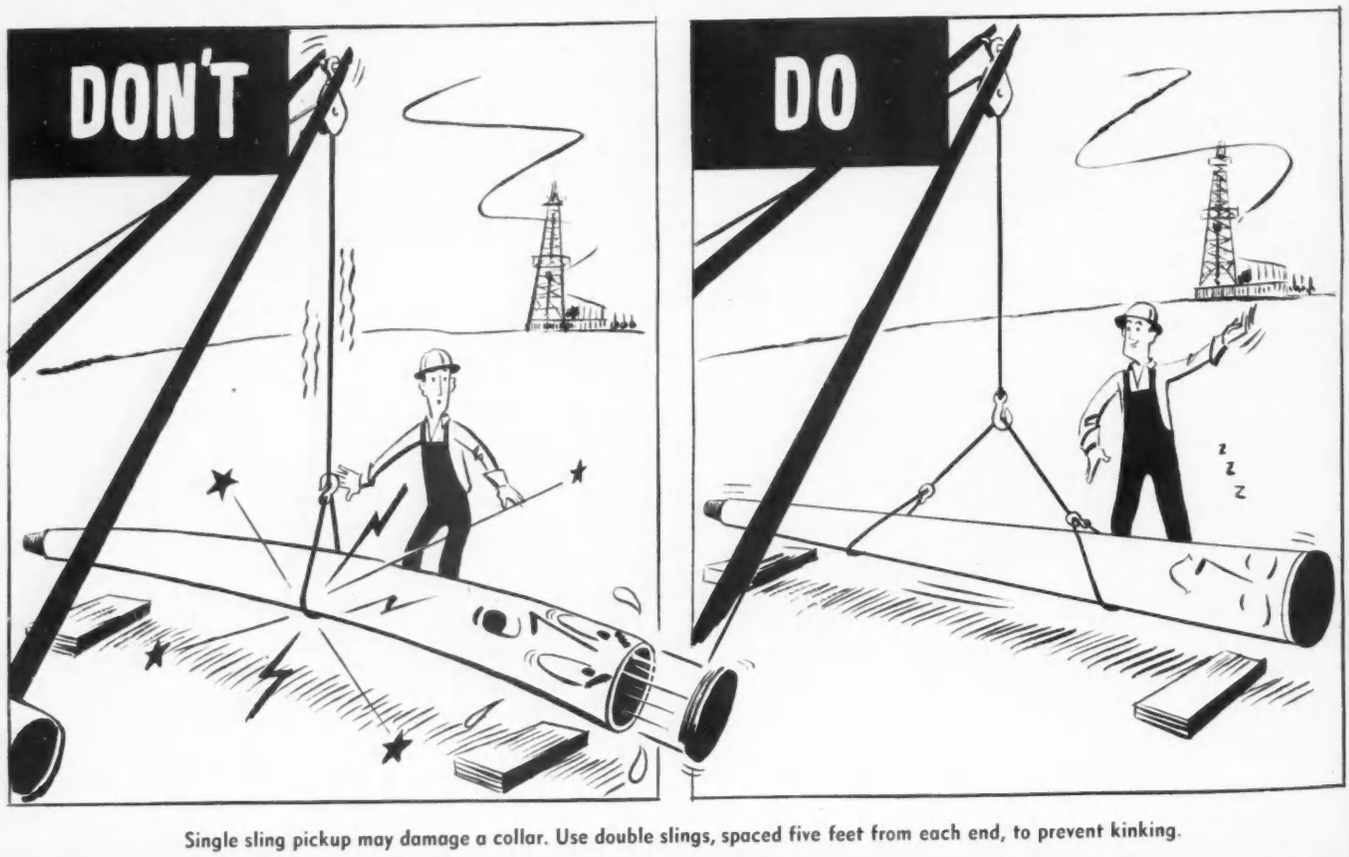
GENERAL OFFICE: 3909 Hemphill Street • Fort Worth 9, Texas
FIELD STATIONS: Shreveport • Ardmore • Lindsay • Shawnee • Corpus Christi
Falfurrias • Houston • Kilgore • Odessa • Hobbs • Wichita Falls

World Oil Graphics

DRILL COLLAR CARE



Heavy drill collars in transport must be well boomed and supported by float beds or timbers to avoid permanent kinks.

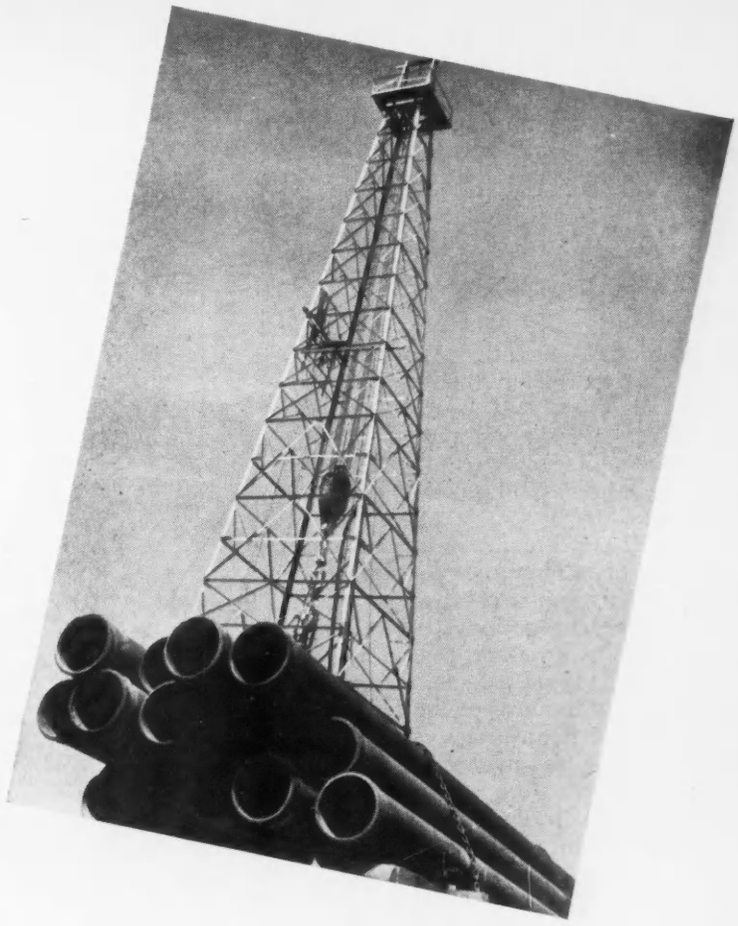


Single sling pickup may damage a collar. Use double slings, spaced five feet from each end, to prevent kinking.

A Review of

Casing String Design, Principles, and Practice

Part 1



By J. O. HILLS, Assistant Manager
Production Engineering and Equipment Section
General Petroleum Corporation

THIS ARTICLE relates the efficient designing of casing strings by the principle of basic engineering. Casing, one of the more critical items within the industry, must be efficiently utilized to promote increased materials conservation. Although several techniques of casing design evaluation have been developed through the years, this is one of the outstanding attempts to consolidate the more important and time proven mechanics of the problem within one paper. Field application of these data will undoubtedly expedite the formulation of better casing programs offering the advantage of tubular goods conservation, optimum safety features, and adequate well protection. This article is from a talk at the Spring Meeting, Pacific Coast District, Division of Production, American Petroleum Institute, Biltmore Hotel, Los Angeles, May 10-11.

CASING string design on an engineering basis becomes of increasing importance as well depth increases, and for very deep strings the weight of the casing must be held at a minimum not only to decrease cost but to provide safety in tension. However, proper design should not be restricted to deep wells, since it will result in economy and uniform safety in wells of any depth.

Conventional assumptions are often used to simplify design procedure even when the actual conditions can be evaluated with reasonable accuracy. For example, the effects of buoyancy often are not calculated and are considered to add to the safety factor. Such procedures tend to obscure the true margins of safety and make it difficult to determine the limits to which design can be carried. Lack of full knowledge of service conditions on casing strings makes it expedient to use some simplified assumptions, but the aim of design should be to do this as little as possible. A casing string is an expensive structure protecting a large investment and the cost of engineering time required for design is relatively small.

A properly designed casing string normally will consist of a number of sections of pipe, each with a different specification. It is essential that these sections be run in the well in proper order, since running even one joint in the wrong place can have disastrous consequences. Because of the difficulty of handling and the occurrence of errors, many operators in the past were reluctant to run these "combination" strings. Today, however, the combination string, and the necessary precautions in handling and running it, are generally considered routine. It is still desirable to restrict the sections to a reasonable number and to avoid joint changes

which make crossover joints necessary. It is also good practice to use at the top a joint or two of the heaviest weight pipe in the string. This tends to prevent starting tools in the hole which will not pass through the entire string, and also provides a thicker pipe wall where the landing slips are set.

Casing Strength Information

Necessary basic data on collapse, tension, and bursting strengths of American Petroleum Institute casing are available in API Bulletins 502[17] and 5A1.[18] The latter, though informational only, gives strengths for API threads on upset and specially treated ends.

All API performance data are given in terms of minimum strengths. Collapse and tension strengths are calculated by formulas derived from test results on full-sized casing specimens.[17] A percentage factor arrived at by statistical analysis of the test data is applied to the average values from the formulas to give the published minimums. Bursting strengths are derived from Barlow's formula using API minimum yield strengths with API minimum wall thicknesses.[18]

In their 1940 report[10] recommending the adoption of minimum strength values by the API, Wescott, Dunlop and Kemler expressed the hope and expectation that future test work and improvements in manufacture would result in adoption of higher minimum strength values. Unfortunately, such increases have not materialized, and the present API minimum strengths are those adopted in 1941.

Strength data for nonAPI pipe and threaded connections are obtainable from manufacturers' catalogs. Such data should be checked to determine if they are on the same basis as API strengths, although manufacturers are generally consistent in this respect.

Biaxial Stress

In applying casing strength data, the effect of combined axial and hoop stresses should be considered. This effect is important in casing string design chiefly because of the reduction of collapse strength due to the hanging weight of the pipe. Theoretical investigations of Holmquist and Nadai[7,19] and experimental work of Edwards and Miller[20] indicate that the effect can be represented by the relationship shown in Figure 2. By examination of this figure it can be seen that tension always reduces the collapse strength of casing, while moderate degrees of compression will result in an increase.

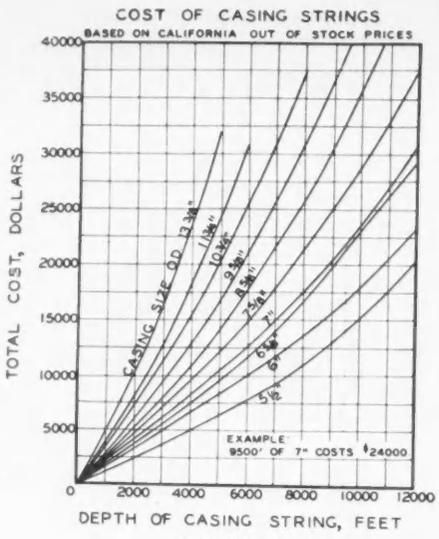

COST OF CASING STRINGS
BASED ON CALIFORNIA OUT OF STOCK PRICES
TOTAL COST, DOLLARS
DEPTH OF CASING STRING, FEET
CASING SIZE OD
EXAMPLE
9500' OF 7" COSTS $24000

FIGURE 1

Loads on Casing Strings and Their Application in Design

Three chief types of loading which casing strings must withstand are collapse, tension and bursting. The sources and characteristics of these loads and determination of their magnitude are illustrated and discussed below. However, there are other considerations which may be of equal or greater importance, and which are often limiting factors in the choice of casing.

These other considerations include wear, corrosion, vibration and pounding by drill pipe, effects of gun perforating, erosion, and general abuse by tools and equipment run in the well. They are not readily subject to calculation, and are met by applying the lessons of experience. This usually takes the form of specifying a minimum wall thickness or pipe weight for various casing sizes and service conditions. Tests by Oliphant and Farris[21] indicate that the stronger grades of casing resist splitting by gun perforating better than the weaker grades, and field experience seems ti confirm this. Individual opinions vary considerably on these matters, but the proper approach certainly is to consider each type of case separately, specifying minimum wall thickness or strength after reviewing experience data and studying the probable importance of these considerations.

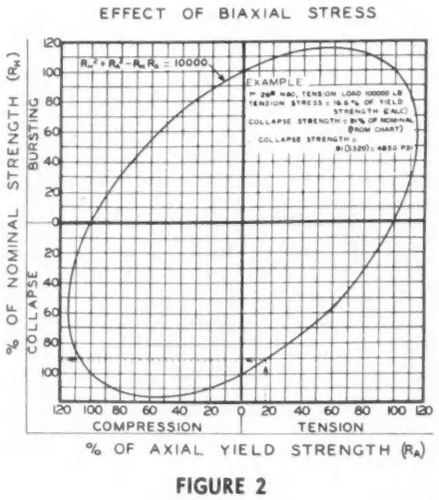


FIGURE 2

Collapse: Collapse loading on casing strings is caused by an external pressure higher than that inside the casing and is illustrated in Figure 3.

The most severe condition, and one commonly used for design purposes, is represented on Figure 3 by the mud pressure line and no internal pressure. This corresponds to a well emptied of fluid, zero pressure on the casinghead, and a full column of mud outside the casing. The casing collapse strength lines on Figure 3 are for a string of pipe strong enough to meet this condition with a margin of safety. The strength lines slope because of the effect of biaxial stress, and are shown only for lower sections where collapse is critical. Reduction of this maximum design pressure should be assumed only if one or more of the modifying conditions discussed below is almost a certainty.

Any internal pressure that will be maintained for the life of the well will allow a reduction of the collapse pressure to an amount indicated by the difference between internal pressure and mud pressure in Figure 3. In case of a protection string which will always be full of mud, little or no collapse loading will ever be applied.

Often the mud in which casing is run is known to be heavier than needed to balance the formation pressure. If it is certain that the mud and formation pressures will have equalized by the time the internal pressure is removed, formation pressure can be used as the external design pressure.

Cement placed around the bottom will give some protection against collapse and may justify a slightly reduced collapse safety factor. Also favoring a lower safety factor at bottom is the fact that the internal pressure is more likely to be maintained there than further up the string.

One fairly common well operation which can result in abnormally high collapse pressure is a squeeze job as illustrated in Figure 4. Because fluid cement in the drill pipe usually is

WOULD YOU RISK YOUR DRIVE TO SAVE A BALL?

Sometimes you may get a pretty fair drive by teeing off with an old ball to save a new one. And sometimes you get a pretty fair oil well even though you attempt to perforate the casing with out-moded methods. But the record of thousands of JET perforated wells shows that you best protect your well investment, and obtain increased productivity by perforating with Welex Jets. That is why more than 50% of all casing perforating done in the U. S. today is done by the JET process originated by Welex. Welex Jet Perforating gives you the economy of *positive penetration and known hole density* . . . with *no burr, no fracturing,* and *no debris* left in the well. Results cost less with Welex Jets. Call your nearest Welex Station for prompt service day or night.

ORIGINATORS OF Welex JET PERFORATING

Welex
JET SERVICES INC.

GENERAL OFFICE: 3909 Hemphill Street • Fort Worth 9, Texas
FIELD STATIONS: Shreveport • Ardmore • Lindsay • Shawnee • Corpus Christi
Falfurrias • Houston • Kilgore • Odessa • Hobbs • Wichita Falls

heavier than mud in the casing, collapsing pressure imposed on the casing above the retainer may be considerably greater than surface pressure. As shown by the dotted pressure line, the collapse load can be reduced by surface pressure applied to the casing, but in wells where squeeze jobs are likely to occur, stronger pipe should be considered.

Tension: The weight of pipe when hanging free before cementing is the most readily calculable tension condition, and is the loading condition commonly used for design purposes. It is illustrated in Figure 5 for a string of pipe with a light weight center section. Diagrammed at the right of the figure are API joint strengths capable of supporting the string with minimum safety factors of approximately 2.0 at the critical points. Location of the casing yield strength as shown is typical of standard API joins, for which the yield strength of the pipe body is greater than API joint strength. For upset or other high strength joints the reverse is often true, and body yield strength rather than strength of the joint may limit the design.

When the casing string is being run in the hole it will be subjected to acceleration loading by setting of slips and application of hoist brakes. If the string should stick it may be subjected to high tension loads in an attempt to pull it free.

Buoyancy: Figure 6 compares tension loading conditions of pipe hanging in air and in mud. The effect of buoyancy on pipe strings hanging in fluid has been analyzed by Klinkenberg,[22] Hawkins and Lamont,[23] Holmquist,[24] and Payne.[25] These analyses show that the effect is as shown by the "Load in Mud" curve on Figure 6, and that compression loading due to fluid pressure acting on bottom does not tend to cause buckling. Load increase from the bottom of the hole upward is at the same rate as if the pipe were hanging in air. Since the pipe weight (and therefore the cross-sectional area) changes at "A" and "B," mud pressure on the differential area results in an abrupt change in load at these points. This load change is equal to the mud pressure at each point times the change in area at that point. When the greater area is in the lower section the load in the upper section is greater, and vice versa.

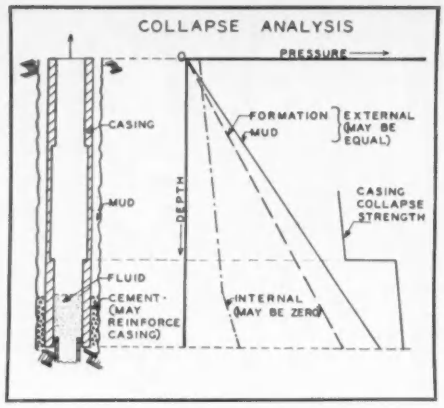


FIGURE 3

The net effect of buoyancy is a substantial amount, varying from about 14 percent of the unbuoyed weight when the pipe is hanging in 70 pounds per cubic foot mud to 20 percent in 100 pounds per cubic foot mud. It is felt that this effect should be included in casing string design practice.

Tension Variations in Service: Throughout its service life after cementing is started, a casing string is subjected to varying tension loads. During cementing, buoyancy of the cement will tend to decrease the load. After being landed permanently, increased internal pressure or decreased temperature will increase tensile load, while internal pressure decrease or temperature increase will have the opposite effect.

The factors involved in landing casing and their evaluation have been investigated by De Hetre[26] and by Oberg and Masters.[27] These investigations indicate that it is important to give engineering consideration to the landing of casing. Casing should be landed at the minimum load that will not cause a dangerous degree of column loading to develop at any time. For very severe anticipated

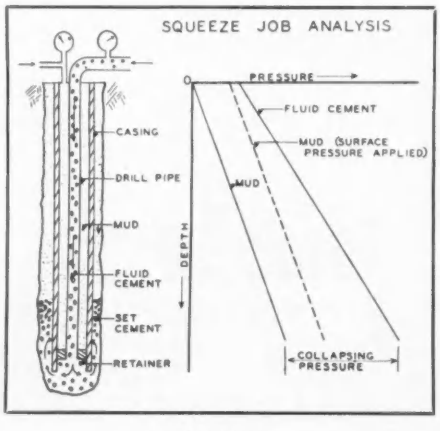


FIGURE 4

temperature and pressure changes, it may be desirable to use casing with higher tension strength than would otherwise be necessary.

Fortunately, increased tension due to temperature and pressure changes after landing casing is not likely to be accompanied by shock or acceleration loading, so tension load can safely be higher under such conditions than while running the string. Thomas and Bartok[28] found that API joints properly made up will not leak until the tension load approaches the yield strength in the critical section of the joint near the last engaged thread. Such a loading corresponds to a tension safety factor below 1.4.

In spite of the fine work of De Hetre and Oberg, and Masters, the problem of landing casing is not well understood, and more study and investigation is needed.

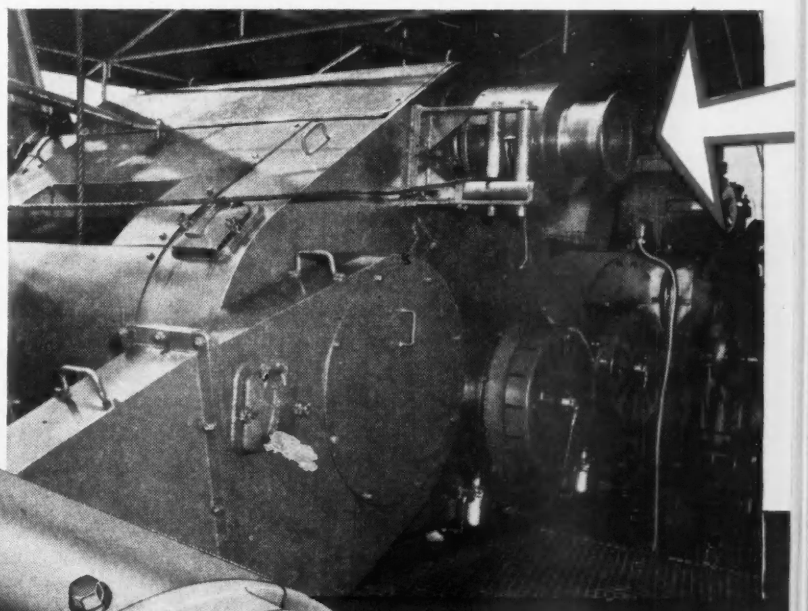
Design for Effect of Biaxial Stress: Tension loading at the time the casing is hanging free in the hole before cementing, is commonly used as the basis for determining the change of collapse strength due to tension. This is a purely conventional assumption, since the casing must at least be cemented and landed before a critical collapse loading can be applied. However, it is felt that this assumption is the best available, but that the true effect of buoyancy (Figure 6) should be included. This procedure is advocated by Curran.[29] It probably is conservative since the same condition which causes the collapse loading (reduction of internal pressure) causes further reduction of longitudinal tension. This last mentioned tension reduction can be evaluated,[22,26] and could be included in design, but the resulting calculated increase in collapse strength may not be realized because of variation in landing practice and temperature changes. Payne[25] argues that the effects of tension on collapse strength in deep strings should be ignored because the bottom section is in compression. This does not seem to be a proper procedure, since collapse often is critical at points far off bottom where the casing definitely is in tension, and when the pipe is in compression the collapse resistance is actually increased.

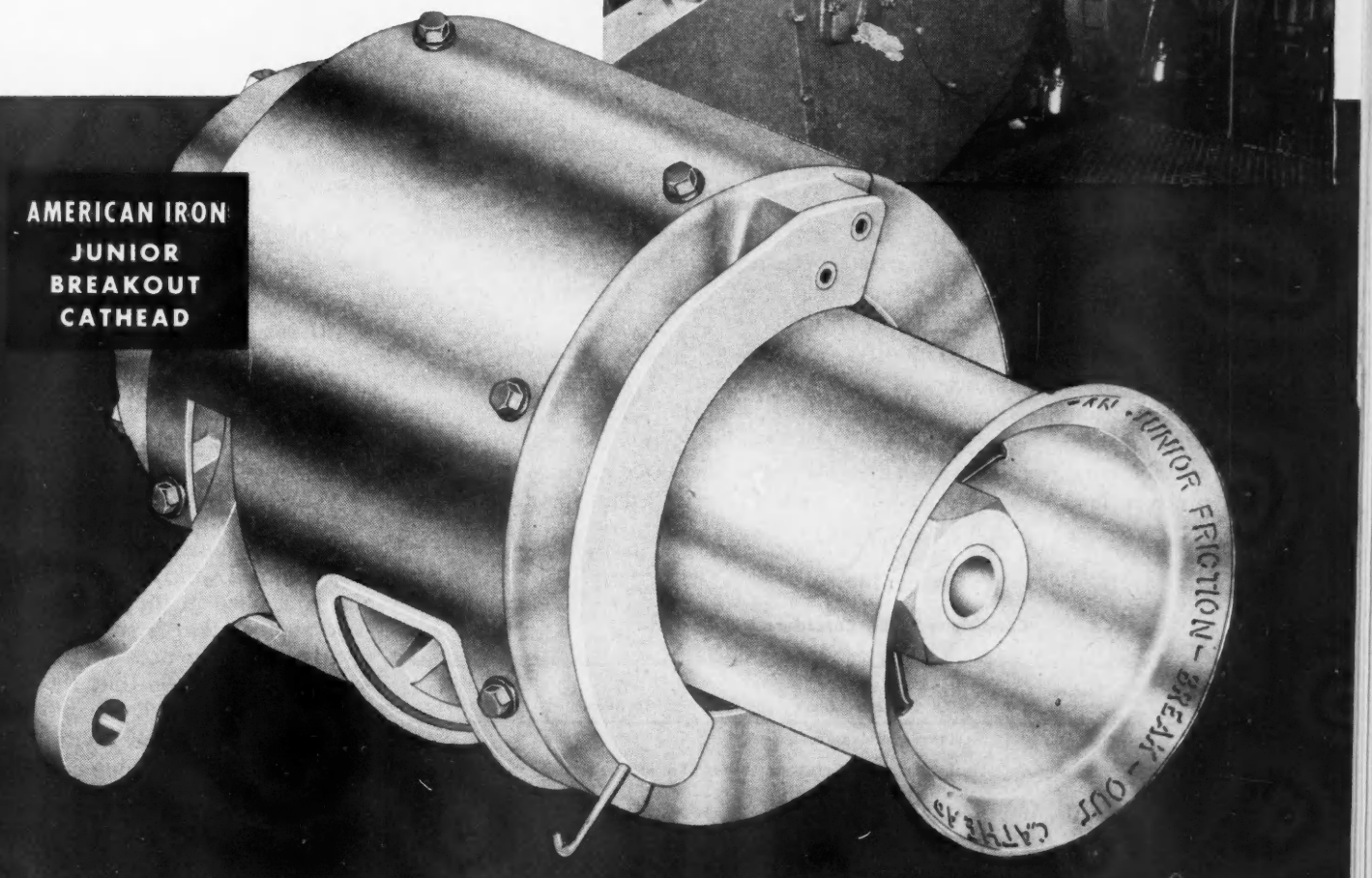
Overpull to Failure: Normal design practice is to apply a uniform limiting tension safety factor throughout each string. Figure 7 illustrates a result of this practice. Assuming that casing at the surface and at depth F

PLUS!

FRICTION CATHEADS

Don't let the name fool you — these "Juniors" do *man-size* jobs! When it comes to performance, they're BIG! Yet, because of their light weight and compactness, they can be safely and economically installed on *any size drawworks!* Actual installations — in many fields — are daily demonstrating the amazing capacity of these American Iron Junior Friction Catheads to makeup and breakout *any size* rotary tool joint connection!





AMERICAN IRON & MACHINE WORKS CO.

OKLAHOMA CITY, OKLAHOMA • BOX 1177 • PHONE L. D. 518 • DISTRICT OFFICE: HOUSTON, TEXAS

EXPORT OFFICE: 11 WEST 42nd ST., NEW YORK CITY, N. Y.

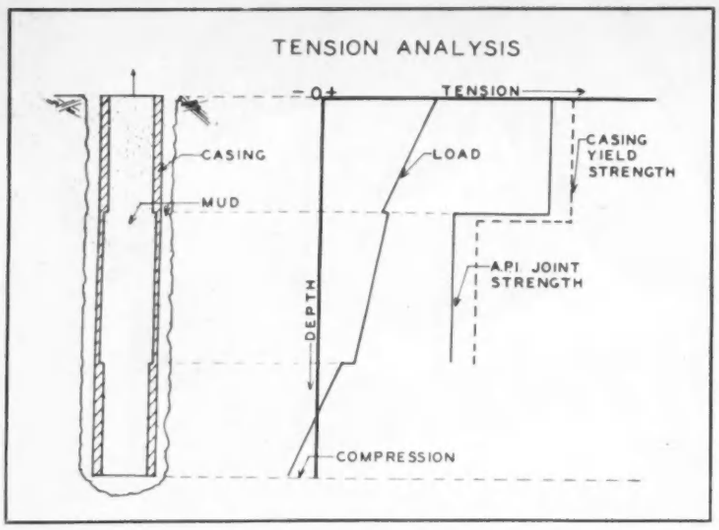


FIGURE 5

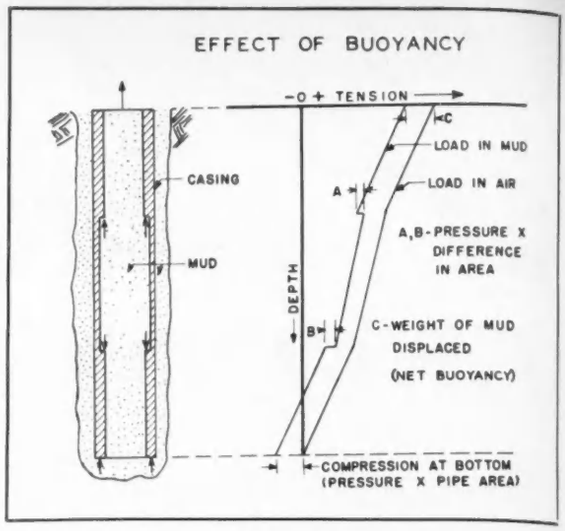


FIGURE 6

are loaded to the same safety factor, casing at the surface must be stronger than at F as illustrated by the joint strength lines. If the string is stuck below depth F and pulled to failure, it will fail at depth F at an overpull shown as A. The total pull to failure will be less than the joint strength of the pipe at the surface. It is sometimes desirable to alter tension safety factors by making the available overpull more nearly equal at critical points.

Tension Loading Summary: It is evident that for tension a dependable maximum loading cannot be calculated because of acceleration loading and possible overpulls, but the free hanging weight of the string appears to be the best basis for design.

Bursting: Figure 8 illustrates the factors involved in determining bursting load on a casing string. This load is equal to the excess of internal over external pressure as illustrated by differential pressure A. Diagrammed at the right are casing bursting strengths capable of meeting, with a margin of safety, the condition shown by the solid pressure lines.

The external pressure opposing bursting can be zero at the surface and perhaps for some distance down the hole, but will be at least equal to the fluid pressures in the formations surrounding the casing.

Maximum internal pressure from within the well itself would be caused by a hole full of dry gas at a bottom hole pressure equal to that of the mud used to drill the producing zone. This is a severe condition not often encountered in California, and, when possible, design is based on expected shutin casinghead pressures. Fortunately, the casing required to meet tension and collapse conditions usually proves strong enough for normal bursting loads. If a casing string is to be used for injection purposes it may be subjected to higher bursting pressures than indicated above, as illustrated by the broken line in Figure 8.

Predicted bursting pressures may or may not be real maximums, but there is no shock loading to consider. Surface pressure on a casing string is easily measured at any time, and may be controlled to some extent.

TABLE 1

Conditions To Be Considered in Design

Service Condition	Surface Strings	Protection Strings	Oil Strings	Liners
Collapse	Not normally	No, if mud level always maintained inside	Yes	No
Tension	Not notmally	Yes, Landing practice important	Yes, Landing practice important	No
Bursting	Yes, for blowout prevention	No, unless to be used as oil string in future	Yes	No
Internal Wear	Yes	Yes	Yes	Yes
Corrosion	Seldom	Seldom	Yes	Yes
Gun Perforating	No	Not normally	Yes	Occasionally
Fatigue	Yes	Yes	Yes	No
Sand Erosion	No	No	No	Yes

Casing Strings, Safety Factors

Table 1 lists the design considerations for various types of strings run in an oil well. Complete design is most important for water shutoff.

It is apparent that the service conditions of liners and surface strings must be met chiefly by choice of adequate wall thickness, but protection strings may have to be designed on the same basis as water shutoff strings.

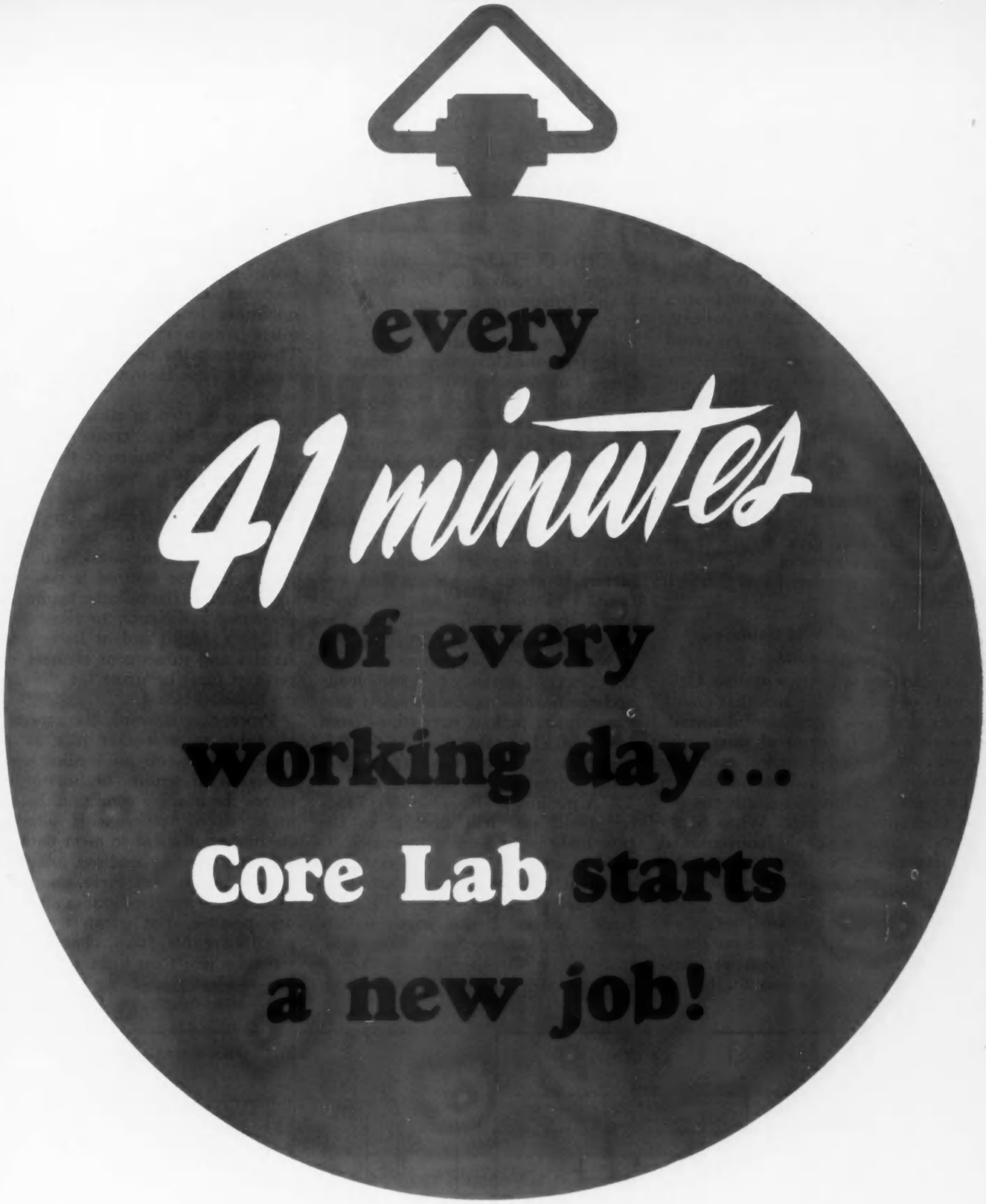
Choice of suitable factors of safety in any engineering design must be based largely on the following considerations:

- Reliability and accuracy of the strength data used for design.
- Comparison of service conditions and test conditions used for determining strength data used for design.
- Reliability and accuracy of the loading assumptions used for design.
- The consequences of failure.

API casing strength data are minimum values and thus permit loadings very close to the listed strengths with little hazard of failure. However, such high loadings make it imperative that no defective material be used and make complete and careful inspection of casing very important.

When designing for collapse, the load assumed will rarely be exceeded, and is applied in the same relatively slow manner that is used in collapse testing. Consequences of failure are serious economically, but there is no hazard to personnel. Therefore, the only reason for use of a safety factor more than 1.0 is the high cost of failure, and a safety factor of 1⅛ appears ample.

When designing for tension, the load assumed is not necessarily a maximum, and acceleration loading



"Providing more reservoir revenue . . . through the production of more recoverable oil."

exists. Failure would be expensive, and there is some hazard to personnel. Therefore, tension safety factors approaching 2.0 on ultimate joint strength are indicated. The factor need not be this high on yield strength of the pipe body, since yielding would not necessarily result in actual failure. A safety factor of 1.5 on body yield strength appears ample.

For bursting, maximum possible theoretical loading may or may not be assumed, failure would be expensive, and there is hazard to personnel. However, failure would result from a slowly applied load, and the strength used for design is based on yield rather than ultimate strength. Where theoretical maximum pressures are used for design, the safety factor can be about the same as for collapse, but otherwise must be higher.

Obviously, the ultimate test of the suitability of safety factors is actual application. Field experience appears to confirm that safety factors in the ranges discussed give ample safety when the conditions of wear, corrosion, etc., are considered and provided for separately.

Design Practice of California Operators

A canvass of representative California operators indicates that casing string design is given careful consideration in the interest of safety and economy. Design practice conforms generally to the principles outlined in this paper, except as regards the use of buoyancy in design. When buoyancy is considered, the conventional assumption is made that buoyancy acts over the entire length of the string.

All operators canvassed base their design loading for collapse on actual mud weight or formation pressure, and all make corrections for biaxial stress. Preference for collapse safety factors is about evenly divided between 1.25 and 1.125, the maximum used being 1.33. A few will go below 1.12 at the bottom of the string.

About half the operators consider the effect of buoyancy on tensile loads and these use a minimum safety factor on joint pullout strength of from 1.8 to 2.0. The other half do not calculate the effect of buoyancy and use lower safety factors of from 1.63 to 1.8. A minimum allowable safety factor of 1.5 on yield strength of the pipe body is used quite generally.

Most operators use a safety factor of about 1.50 for bursting, but practice varies from 1.10 to 1.75. This large variation is due partly to differences in loading assumption. Also, bursting pressures are seldom critical is design and generally have not been given much study.

Practically all operators consider wall thickness an important criterion and do not necessarily run the minimum casing weights indicated by the nominal safety factors. For instance, many will not run seven-inch casing lighter than 26 pounds per foot in combination strings.

Design Procedure

The first step in design is to choose the safety factors, the loading conditions, and any limitations desired such as minimum wall thickness, minimum length of sections, maximum number of sections, etc. Throughout the design, conformance with all these factors must be maintained.

The next step in all design procedures must be the choice of pipe to meet collapse loading at the bottom of the hole. It is essential to start at the bottom because the design for tension and corrections for biaxial stress are affected by the weight below each section considered. Pipe chosen for the bottom is continued upward until the collapse loading has decreased sufficiently to allow use of a lighter weight and/or lower grade. At this and subsequent changes, corrections must be made for the effect or biaxial loading.

Proceeding upward, the process of changing to a weaker pipe as permitted by the collapse loading is continued until tension or bursting becomes the limiting condition. Increasingly strong pipe, with allowable strengths sufficient to meet both tension and bursting loadings, are chosen for the top sections. Here, many combinations of weights, grades and joints are possible, but greatest economy usually results from choosing high strength joints on light weights and low grades.

About the Author

JOHN O. HILLS, assistant manager of Production Engineering and Equipment for General Petroleum Corporation, received the B.S. degree in general engineering from the University of Southern California in 1934. Initially employed by General Petroleum in 1929, Hills was assigned various field jobs until 1936, when he became active in the Production Engineering and Equipment Section.

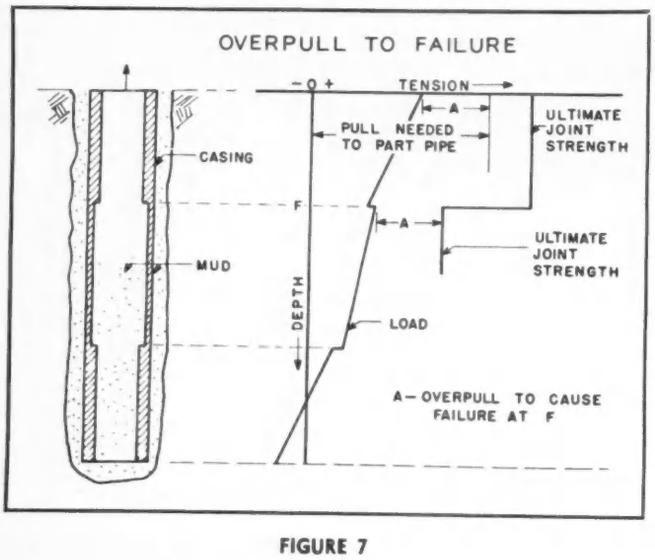


FIGURE 7

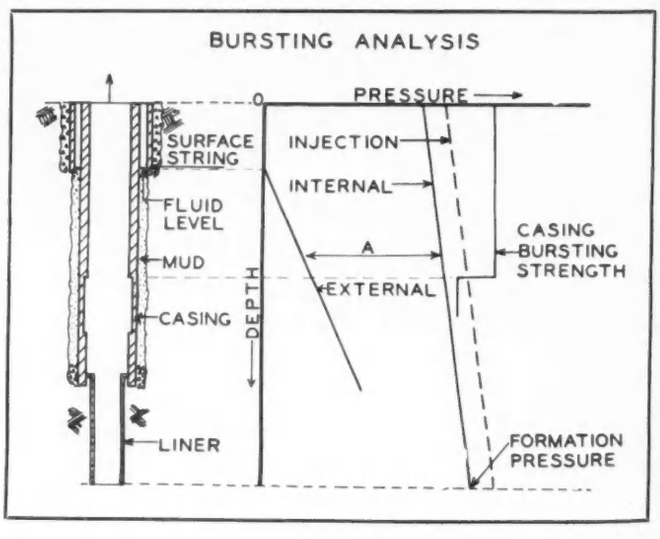


FIGURE 8

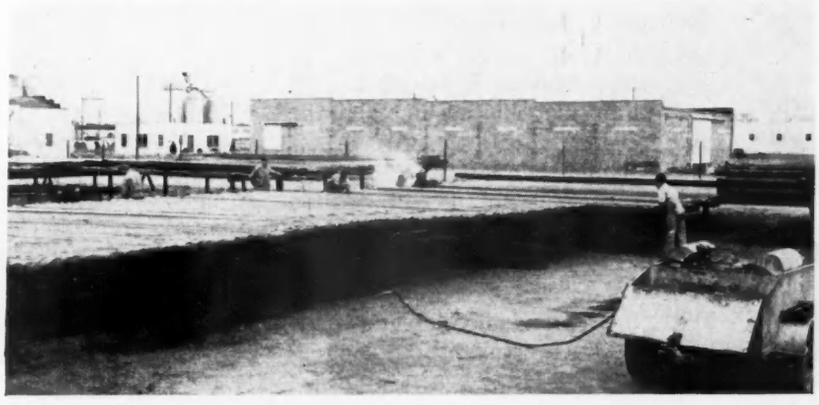
REED
Super Shrink-Grip TOOL JOINTS

BEARDMORE DRILLING COMPANY INC. WICHITA, KANS.

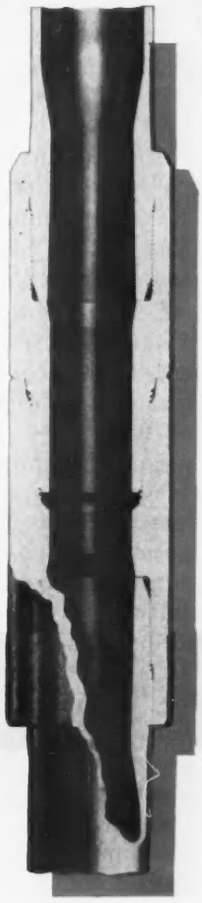
"We use them one hundred percent"

. . . says Heber Beardmore, Jr., President of Beardmore Drilling Company, Inc., Wichita, Kansas.

"We standardized on **REED** Super Shrink-Grip Tool Joints for all our drill strings because we liked the idea of field replacements," Mr. Beardmore said, "and we found that we also get exceptionally long life from **REED** Tool Joints."



This crew is applying **REED** Super Shrink-Grip Tool Joints to a string of pipe for the Beardmore Drilling Company. Field application like this saves both transportation costs and lost rig time, making for lower drilling costs.



REED ROLLER BIT COMPANY

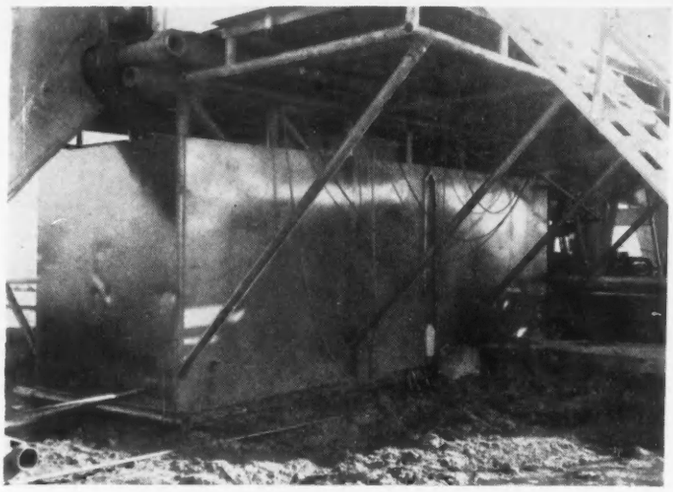
HOUSTON 1, TEXAS

THE MARK OF QUALITY

NEW YORK LONDON BUENOS AIRES

2803

Water Tank Makes Engine Foundation



By GILBERT M. WILSON
WORLD OIL Staff

This combination substructure and water tank, the latter having a capacity of approximately 600 barrels, provides a stable foundation for the engine and transmission platform and reduces the cost of rigging-up. Interior structure is made primarily of 4½-inch drill pipe. Centrifugal pump, V-belt driven from transmission case, is on opposite side of tank.

RIGGING-UP and tearing-down are simplified and operating advantages are gained by use of a unique method developed by Carl B. King Drilling Company, Midland, Texas. The device makes the water supply tank serve the dual purpose of being both a storage reservoir and a stable foundation on which the drilling engines and transmission assembly are mounted.

One of the more recent installations of this type is shown in the accompanying photograph. The rectangular tank is 32 feet long, 7½ feet wide and 9 feet high. Of all-welded construction, the interior structure and bracing are designed to support the weight of the engines and transmission assembly. It is sturdily constructed, principally of 4½-inch drill pipe material, the whole being mounted on an H-beam skid base which rests directly on the ground. Enclosing the structure with steel plate forms a tank having a capacity of approximately 600 barrels. The bottom plates of the tank are of one-fourth-inch, and the sides and top are of 3/16-inch steel plate. The sections of plate are butt welded except at corners where they are welded directly to the sides of the corner posts.

Broad, removable platforms extending out on each side of the platform are supported by diagonal braces made of lengths of pipe set in sockets welded to the tank side at every other column and at points within a foot or so of the tank bottom. The upper end of each brace is fastened by a clevis and pin fitting to the outer edge of the elevated platform.

Solid Foundation

When filled with water, the combination tank and substructure provides a very solid mount, being as sturdy and stable as would a fabricated structural steel base of the type commonly employed. The drawworks is pinned to the derrick floor at the front and to the compound at the rear. Other than that, however, the engine platform is not tied down to the mount, there being no tendency for it to creep due to rig vibration. The compound is V-belted to the mud pump in the usual manner, the pump being set on the ground directly behind the tank.

A centrifugal pump, mounted on the side of the tank opposite the driller is driven by a V-belt drive on the far side of the compound case. With this arrangement, water pressure always is available as long as the compound of the rig is in motion. From the pump, water is piped to the front end of the substructure where a hose connection is made to deliver water to the driller's position so that he easily can control the flow of water to the water-cooled brake rims or to the hydraulic brake. Water lines leaving the brake and rims are connected together into one fitting on the drawworks, and from a third leg of the "Y," a hose is run down to the tank. In rigging-up, it is necessary only to connect the water source line into the tank and connect up the hoses to secure water for any purpose on the floor.

A man-hole of generous size is provided on one side of the tank. Nearby is an easily-seen level indicator connected to a float inside the tank. The indicator, visible in the photograph, is a piece of steel plate, painted white, which moves up and down in an enclosed groove formed by welding parallel lengths of angle iron, open sides facing each other, to the tank side.

While this type of mounting simplifies and speeds general rigging-up and tearing down operations, it also has certain other operating advantages. It is of course advantageous to reduce the number of items that must be spotted on the location, and the closer the individual pieces are to the point where actually needed, the cleaner and simpler will be the lay-out of the location. The combining of the substructure and water tank in this manner, in effect, reduces by one load the number of trips that have to be made in hauling the rig from one location to another. In addition, by having the water tank situated directly below the engines and drawworks, the amount of pipe and work ordinarily required at each location is greatly reduced.

The entire design of the unit is as functional as it is simple and represents a substantial improvement in the manner of mounting and handling these parts of the rig equipment.

The Effect of Mud Filtrates and Mud Particles upon the Permeabilities of Cores

Part 1

By T. J. NOWAK and R. F. KRUEGER
Research Department, Union Oil Company of California, Wilmington, Calif.

TWO distinct problems are involved during completion practice: first, penetration of the zone and secondly, the subsequent mechanical operations. The first part of this series deals with the effect of aqueous solutions and field mud filtrates on the effective oil permeability of oil-bearing sand cores which are known to be water sensitive. This paper is substantially as presented before the 1951 Spring Meeting of the Pacific Coast, Division of Production, API, held in Los Angeles, California.

THE study of the effect of mud filtrates as distinguished from the effect of mud particles upon permeability is predicated on the recognized fact, as indicated by the work of Johnston and Beeson,[1] that the specific permeability of cores from a large number of fields, especially from California reservoirs, will vary radically with the type of fluid used in making the permeability measurement. Fresh water gives a decidedly lower permeability than salt water, which, in turn, is lower than air permeability. These phenomena have been ascribed to the interaction of fluid with the intergranular clay content of the core. These clays swell and shrink, depending upon the nature of the brine with which they are in contact. Recent amplification on this point has been made by Miller, Morgan and Muskat,[2] who reported similar behavior of water on the effective permeability of water sensitive cores and pointed out the qualitative reversibility of permeabilities after each extraction and repetition of a particular fluid sequence. From this it is evident that the effect of mud filtrate on productivity of a well draining a clay containing sand cannot only be postulated on the basis of the relative permeability variation ascribed to the increased water saturation, but also on the variation of pore geometry attributed to the solid-filtrate interaction.

The objective of the study reported herein was to determine whether or not the effective original oil permeability of a water sensitive core could reestablished itself after mud filtrate invasion.

Consolidated sand cores obtained with oil base mud from approximately 11,000 feet in the productive interval of the Stevens Zone of the Paloma field, California, were the source of core specimens in this study. The sand is rather poorly sorted with angular to subrounded grains averaging around 0.40 millimeters in diameter and is composed mainly of quartz, feldspars of sericitic alteration, and fine intergranular dust of montmorillonitic nature.[3] All core specimens were cut parallel to the bedding plane, using oil as the cutting lubricant, to a diameter of one inch and a length of 1½ inches. Subsequently, the cores were extracted with toluene followed by dioxane, and dried at approximately 215° F. About 300 cores were prepared in this manner covering a range of air permeabilities from almost 0 to 350 millidarcys and having an average porosity of 19 percent. The cores selected for the work reported herein covered an air permeability range from 50 to 140-md. This permeability range was found to be sufficiently narrow to minimize the relative effect of a given solution on cores differing in permeability.

The experimental procedure adopted is illustrated graphically in the top portion of Figure 1. Reservoir fluids saturating the cores are represented by synthetic formation water as the wetting phase and refined kerosine (42° API) as the oil or nonwetting phase. Composition of the synthetic formation water approximated the type and concentration of ions found in the Paloma formation water. After measuring air permeability, the cores were evacuated and saturated with synthetic formation water (indicated as S. F. water in Figure 1) and the water permeabilities were determined. To simulate the reservoir saturation states prior to mud filtrate invasion, the cores were next desaturated with oil to interstitial water content by means of the static capillary desaturation technique. This was accomplished by using cellophane Type-600PT as the water-wet diaphragm and applying gradually an oil pressure up to 80 pounds per square inch and maintaining this pressure until equilibrium conditions were reached. At this point the cores, containing only oil and interstitial water, were said to be in the restored state. The interstitial water saturations were determined volumetrically. To check these values, water contents in several cores in the restored state were determined by extraction with toluene and found to agree within 2 percent of the absolute values reported. Effective oil permeabilities at the restored state were determined by the same method used for air and water permeability measurements, namely, placing the core in a thin walled Tygon sleeve, applying a water pressure of 130 psi on the outer

surface of the sleeve to effect a seal along the sides of the core, and measuring the rate of flow at pressure drops in the range of one to three psi across the core.

The procedure in determining the effect of a fluid on the oil permeability of the core consisted of flowing six pore volumes of the fluid e.g., mud filtrate, immersing the core in test solution for six days to establish physicochemical equilibrium between the test fluid and the core system, desaturating the core again to the restored state condition by the above described desaturation technique, measuring the final oil permeability, and determining the final interstitial water saturation by extracting the core with toluene. In presenting the data, the final recovery of oil permeability was expressed as percentage of the original oil permeability. The percentage recovery represents the persistence of the effect of a test fluid on the permeability of the invaded zone.

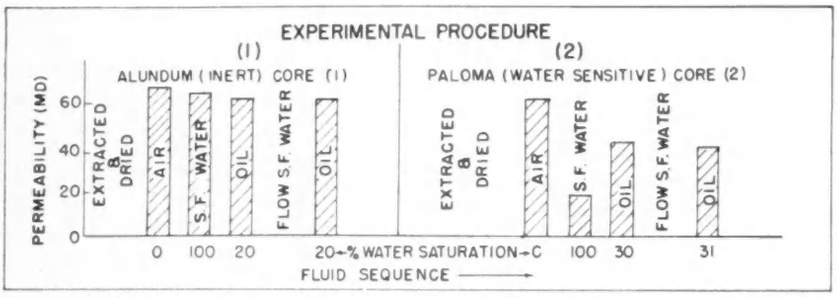
It was necessary to take certain precautions to eliminate particle plugging of cores. For example, freshly prepared fluids were used; the aqueous fluids were covered with oil to protect them from air; and any fluid was passed through a fine fritted glass filter prior to entering the core. The mud filtrates were obtained from field muds by the API fluid loss method. All test solutions were mixed with equal volumes of synthetic formation water and allowed to stand for six days to determine if any chemical interaction caused precipitation. In the experiments herein no precipitation took place. All of the above experiments were made at room temperature.

Results and Discussion

Before discussing the results of this study, the influence of the experimental conditions on effective oil permeability will be pointed out. In the upper portion of Figure 1 is summarized the effect of experimental conditions on the oil permeabilities of cores and the differences in permeability behavior between the inert and water sensitive cores are illustrated. For the cores described, the test solution used was synthetic Paloma formation water. It can be seen that 100 percent of the original oil permeability was recovered in the Alundum core while for the Paloma core the permeability recovery was 96 percent. It is apparent, therefore, that saturation changes within the core imposed by experimental conditions produced no significant changes in effective oil permeability. Referring again to the top portion of Figure 1, a striking contrast in permeability behavior of the two types of cores is apparent, particularly in going from air to water to oil permeability. For the Paloma core, the specific synthetic formation water permeability is considerably lower than the specific air permeability or the effective oil permeability. This permeability behavior appears to be diagnostic for a water sensitive core.

In the lower portion of Figure 1 the effect of various aqueous solutions on oil permeabilities of Paloma cores is illustrated. The effect of distilled water on oil permeability is shown in Test 1. It is seen that the final restored state water saturation is greater (45.8 percent) than before the test (32.5 percent) while the percentage of original permeability recovered was only 26 percent. A possible explanation for increase in water saturation and decrease in oil permeability is based on the interaction of the distilled water with the intergranular clays. When contacted with distilled water these clays swell by absorbing water and thus occupy a greater interstitial volume. Furthermore, the swelling action probably reduces the pore sizes so that at a given capillary pressure a greater water saturation will exist at equilibrium.[4] Thus, the increased interstitial water content and modification of pore geometry are reflected in the low oil permeability recovery.

The other tests in the lower portion of Figure 1 are concerned with salt solutions. Tests 2, 3 and 5 illustrate the effect of solutions containing 1 percent by weight of sodium chloride, calcium chloride and aluminum chloride, respectively. It is apparent that the use of calcium and aluminum salts resulted in a greater recovery of original oil permeability than the use of



EXPERIMENTAL DATA (PALOMA CORES)
(3)

TEST NO.	TEST SOLUTION % BY WT	% INTERSTITIAL WATER BEFORE	% INTERSTITIAL WATER AFTER	% OF ORIGINAL OIL PERMEABILITY RECOVERED
1	DISTILLED WATER	32.5	45.8	26
2	1 % SODIUM CHLORIDE	33.2	41.4	70
3	1 % CALCIUM CHLORIDE	38.4	38.7	100
4	3 % CALCIUM CHLORIDE	29.9	29.1	104
5	1 % ALUMINUM CHLORIDE	33.4	34.3	96

FIGURE 1. Effect of aqueous solutions on oil permeability of Paloma field (Stevens sand) cores.

TEST NO.	TYPE OF MUD FILTRATE	% INTERSTITIAL WATER BEFORE	% INTERSTITIAL WATER AFTER	% OF ORIGINAL OIL PERMEABILITY RECOVERED
6	CLAY-WATER BASE	34.3	37.6	40
7	FRESH WATER-STARCH	34.6	45.3	20
8	FRESH WATER-DRISCOSE	32.2	36.2	35
9	CALCIUM CHLORIDE-STARCH	32.3	25.7	90
10	LIME-STARCH	28.5	27.4	60
11	LIME-TANNATE	36.2	43.3	30
12	FRESH WATER EMULSION	32.0	37.7	25
13	SALT WATER EMULSION	28.8	26.6	50
14	OIL BASE	25.2	24.9	70

FIGURE 2. Effect of field mud filtrates on oil permeability of Paloma field (Stevens sand) cores.

Why Make a Mystery of Wire Rope Costs?

Every once in a while we run across somebody who's hopelessly confused about his wire rope costs. Sure, his books show him the total he spends each year—so much for this brand, so much for that brand, so much for a third. But he never really knows what he's getting from each brand in terms of work.

And work is what he buys with every cent he spends on rope. Work determines the cost—the *actual* cost.

He could easily clear things up by recording what each rope does . . . in terms of ton-miles, cubic yards of rock moved, or other simple, appropriate units. That would give him a basis for actual comparisons of costs and actual comparisons of brands.

Bethlehem has long recommended such a system, and more and more customers are using it. They have found it well worth the minor effort involved, for it's done away with guessing. They've found, too, in keeping such records, that every dollar spent on Bethlehem rope buys a mighty big dollar's worth of service.

LET YOUR RECORDS TELL YOU!

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

sodium salt. In Test 4, 3 percent calcium chloride solution was used and resulted in essentially no change either in the interstitial water saturation or in original oil permeability. Interpretation of these results is possible by considering the behavior of the intergranular clay to the salt solutions. It is known that bentonitic clay has a net negative surface charge[5] which is neutralized by an equivalent number of positive ions, e.g., if sodium ions neutralize the surface charge, the clay is said to be a sodium clay. Because of large concentration of sodium ions in the synthetic Paloma formation water, intergranular clays are believed to be sodium clays. By replacement with calcium ions, sodium clays can be transformed into calcium clays and will occupy less space than the corresponding sodium clays.[6] These hypothetical considerations are supported by the data on the salt solutions shown in Figure 1.

Figure 2 shows the effect of field mud filtrates on oil permeabilities of Paloma cores. Each test number represents an individual core. However, in many instances more than one core was tested for a given mud filtrate. It is apparent that the filtrates from muds of low salt content caused low percentage recoveries of the original oil permeabilities. For the calcium chloride-starch mud an oil permeability somewhat greater than the original was obtained and at the same time the final interstitial water saturation (25.7 percent) was lower than the original interstitial water content (32.3 percent). In the case of the oil base mud filtrate the original oil permeability was essentially recovered. These findings are in substantial agreement with the clay swelling hypothesis previously discussed.

The evaluation of the effects of mud filtrate upon permeability involves an elaborate and time-consuming procedure. To overcome this disadvantage a simple test was devised to indicate visually the probable effect of a given mud filtrate on permeabilities of water sensitive cores. The test consisted of adding one gram of Wyoming bentonite (sodium clay) to 21 milliliters of mud filtrate and shaking the mixture. The resulting equilibrium clay settling volume served as a clay-filtrate interaction index. In Figure 3 a correlation is presented between the effect of mud filtrates upon oil permeabilities and the effect upon settling volumes obtained with the respective filtrates. The correlation illustrates that percentage recovery of original oil permeability for a given mud filtrate is inversely proportional to its clay settling volume. From Figure 3 it will be noted that clay settling volume of the clay-water base mud filtrate is relatively small. This is believed to result from a considerable chemical treatment of the mud.

In Figures 1, 2 and 3, data for the percentage of original oil permeability recovered as a result of mud filtrate invasion represent the case in which the reservoir capillary forces have reestablished equilibrium fluid saturation, and give indication neither as to time required for this process to occur nor as to the manner in which capillary forces are affected by dynamic flow conditions existing around the well bore. To obtain information on recovery of oil permeability of fresh water invaded cores as a function of the pore volumes of oil backflow, an extracted and dried Paloma core was mounted in Lucite and subjected to a sequence of operations as illustrated in Figure 4. The bar graphs in this figure represent the permeabilities for the respective fluid sequences. Up to and including Sequence 4, at which point the core was in the restored state, a standardized experimental procedure was followed; thereafter the procedure was modified as indicated below.

Sequence 5 represents the flow of

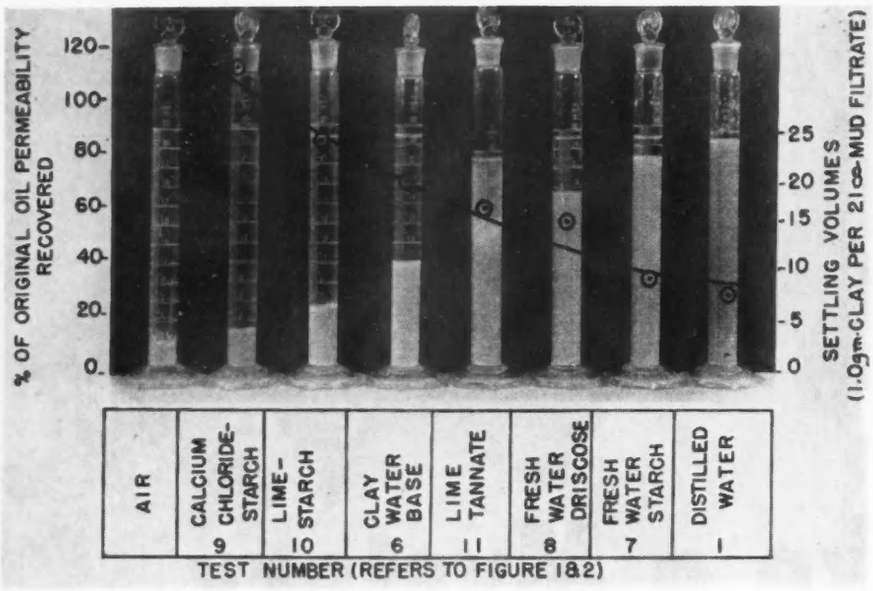


FIGURE 3. Effect of field mud filtrates on permeability of Paloma field cores and settling volumes of Wyoming bentonite.

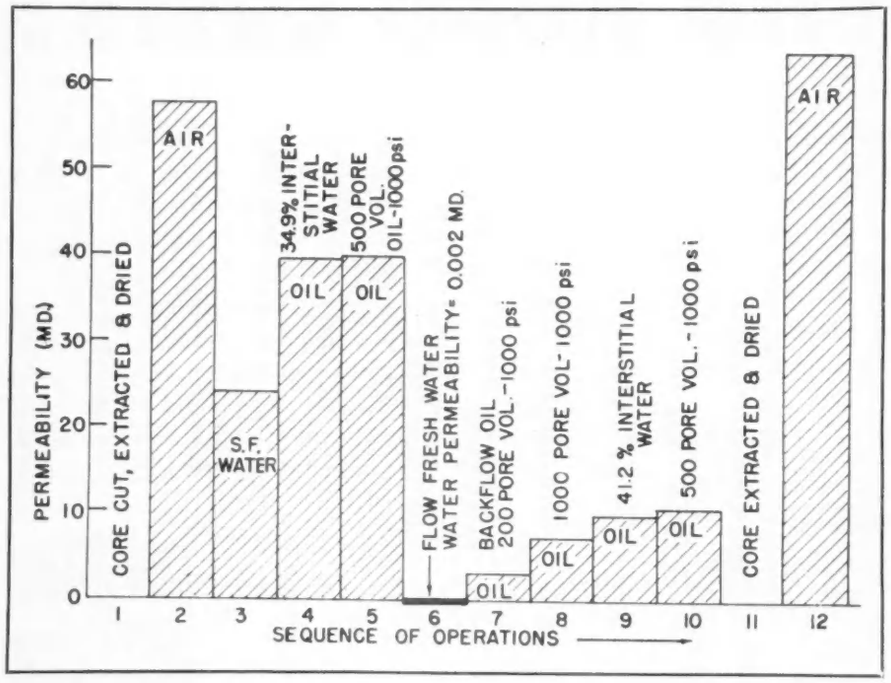


FIGURE 4. Typical permeability history of water sensitive core (Paloma field, Stevens sand).

What Keeps <u>These</u> Compressors on the Job?

Wherever you put it, indoors or out . . . whatever task you give it, repressuring, booster service or air-gas lift . . . the Worthington HB Flare Gas Compressor will stay on the job.

There's real rugged construction in the one-piece frame, heavily ribbed inside, extended to include cylinder flange. Crankshaft, too—one-piece, counterbalanced, forged, heat treated, machined and ground to precision limits.

Or: take the valves. They're Worthington Feather* Valves, light-weight, but tight. No buffer plates or cushioning devices. The simplest valves made—no valve-grinding needed.

Add on such features as large-area one-piece cylinders, extra-large water jackets, forged steel semi-marine type connecting rods, anti-friction roller bearings, and automatic lubrication—and you've got a compressor that can take care of itself when the going gets rough!

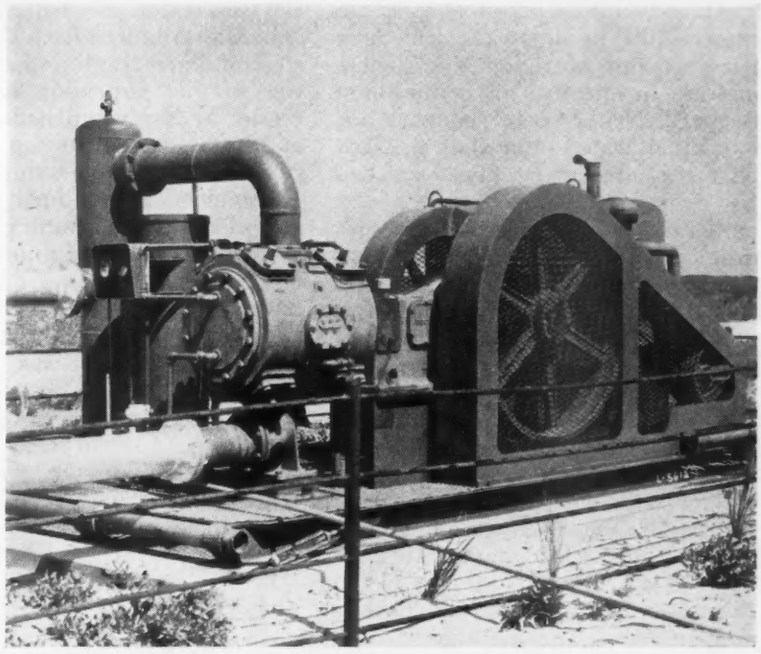
For good measure, each is equipped with QD Sheaves, originally developed by Worthington for oil field service.

WIDE RANGE AVAILABLE FROM LOCAL STOCK

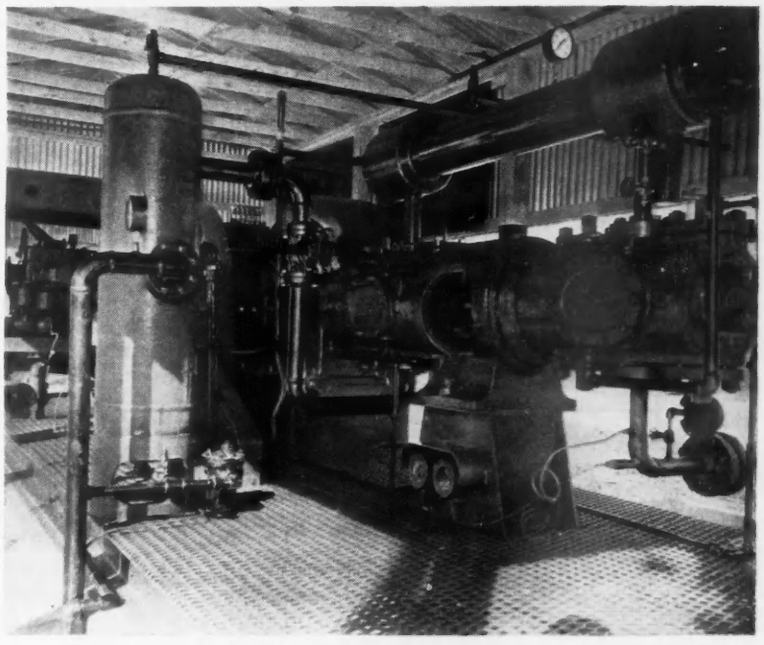
Worthington makes all sizes for any pressure range. Units available from stock in Tulsa, Houston, Dallas, Los Angeles—or from your local oil field distributor.

Have us send you Bulletin L-640-B1B, so you can see why *there's more worth in Worthington*. Worthington Pump and Machinery Corporation, Pump and Compressor Merchandising Division, Harrison, New Jersey.

*Reg. U. S. Pat. Off.



PORTABLE Worthington HB "Packaged" Flare Gas Compressor used by El Paso Natural Gas Co., Jal, N. M.



STATIONARY Worthington HB "Tandem" Gas Compressor, driven by engine. May also be motor-driven.

PC.1.12

WORTHINGTON

THE GOOD RIGHT HAND OF INDUSTRY

POWER TRANSMISSION: sheaves, V-belts, variable speed drives

PUMPS: centrifugal, power, rotary, steam

AIR COMPRESSORS: water-cooled, air-cooled

Worthington Pump and Machinery Corp.
Pump and Compressor Merchandising Div.
Harrison, N. J.

Send latest bulletin L-640-B1B on Worthington HB Flare Gas Compressor.

Name.....

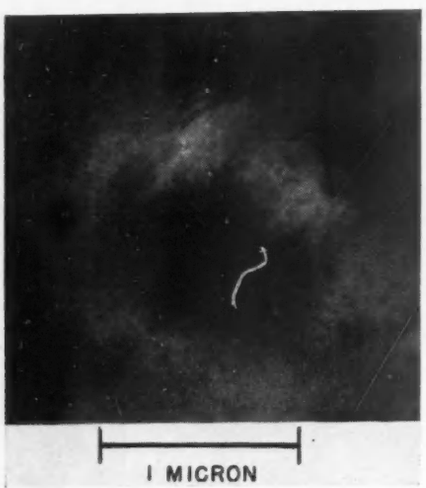
Company.....

Address.....

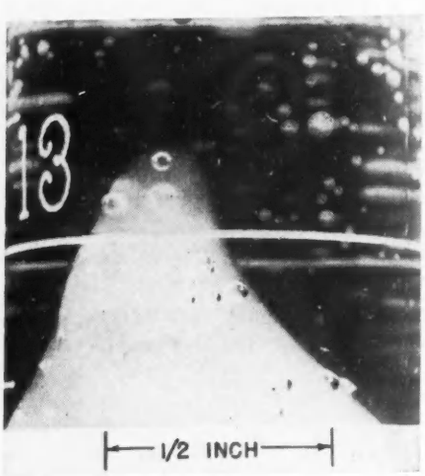
City.....State.....

500-pore volumes of oil at pressure drop of 1000-psi across the core. As a result of this operation a negligible increase in effective oil permeability occurred. Neither pore geometry nor interstitial water saturation was appreciably affected by this operation. In Sequence 6, fresh water was passed through the core at a pressure drop of 50-psi and both oil and water were produced from the core. The effective water permeability after flow of less than one pore volume was reduced almost to zero. The pressure drop was then increased gradually to 1000-psi and flow continued until six pore volumes were forced through the core. During this flow sequence several observations were noted which suggest the nature of the interaction of the intergranular clays with fresh water. For example, it was observed that above a pressure drop of 50-psi a clay suspension of gelatinous appearance was produced from the core. An electron micrograph of the clay particles in this suspension is shown in Figure 5. X-ray diffraction patterns and infrared absorption spectra identify the clay as a montmorillonite type (bentonite). It was further observed that effective fresh water permeability of the core appeared to be a function of pressure drop across the core, i.e., 0.002 md. at 3 psi, 0.035 md. at 400 psi, 0.450 md. at 1000 psi, and upon reverting to 3 psi it was again 0.002 md.

FIGURE 5. Clay suspension and emulsion produced from Paloma core.



(Sequence 6)
Electron micrograph of clay suspension produced from Paloma core upon flowing fresh water at $\Delta P > 50$ psi.



(Sequences 7 and 8)
Oil-water emulsion produced from Paloma core upon backflow of oil at $\Delta P > 50$ psi after fresh water flow.

Extraction from the core of a montmorillonite type of clay with fresh water substantiates the hypothesis that the intergranular clay minerals interact with mud filtrate and thus affect permeability. It is speculated that flow of fresh water through the core at low pressure drops produces plugging of the pores with intergranular clay which permits diffusion type flow, whereas at high pressure drops, clay particles flow with the water and impart high viscosity to the flowing stream. Both types of flow result in low water permeability.

Referring again to Figure 4, following fresh water flow, oil was backflowed at a pressure drop of 1000-psi (Sequences 7 and 8) and the effective oil permeability measured after 200-pore volume throughput and after an additional 1000-pore volume throughput. Comparing original oil permeability (Sequence 5) with the oil permeability recovered (Sequences 7 and 8) it is apparent that the rate of oil recovery with pore volume throughput at high pressure drops is slow. During the oil backflow operations, a white emulsion was produced from the core. A photograph of this emulsion is also shown in Figure 5. The full import of this phenomenon has not been ascertained. After the backflow tests, the core was placed in a static capillary desaturation cell and reduced to restored state. Comparison of the oil permeability (Sequence 9) with the original oil permeability (Sequence 5) indicates that recovery of permeability is small. In Sequence 10, five hundred pore volumes of oil were flowed at 1000 psi to determine if additional recovery over that in Sequence 9 could be obtained. The observed small increase may indicate that the ultimate recovery of original oil permeability is probably somewhat greater as a result of backflow of oil than is indicated by static desaturation of the core to restored state.

Final air permeability after extraction and drying (Sequence 12) was substantially higher than the original value (Sequence 2). This latter observation has been noted on a large number of water sensitive cores.

BIBLIOGRAPHY

[1] Johnston, N., and Beeson, C. M., "Water Permeability of Reservoir Sands," AIME, Vol. 160, 43-55 (1945).

[2] Miller, K. T., Morgan, F., and Muskat, M., "Some Permeability Experiments on Cores from the Stevens Sand, Paloma Field, California," *Producers Monthly*, November, 1946.

[3] Nahin, P. G., and Crog, R. S. "Mineralogical Studies of California Oil-Bearing Formations. II. Role of Clay—Analyses of Natural Cores," AIME, Los Angeles Meeting of Petroleum Branch, October 13, 1950.

[4] Rose, W., and Bruce, W. A., "Evaluation of Capillary Character in Petroleum Reservoir Rock," AIME, Vol. 186, 127-142 (1949).

[5] Grim, R. E., "Modern Concepts of Clay Materials," *Journal of Geology*, Vol. L, No. 3, April-May, 1942.

[6] Marshall, C. E., *The Colloid Chemistry of the Silicate Minerals*, Vol. 1, p. 163, Academic Press Inc. (1949), New York, N. Y.

About the Authors

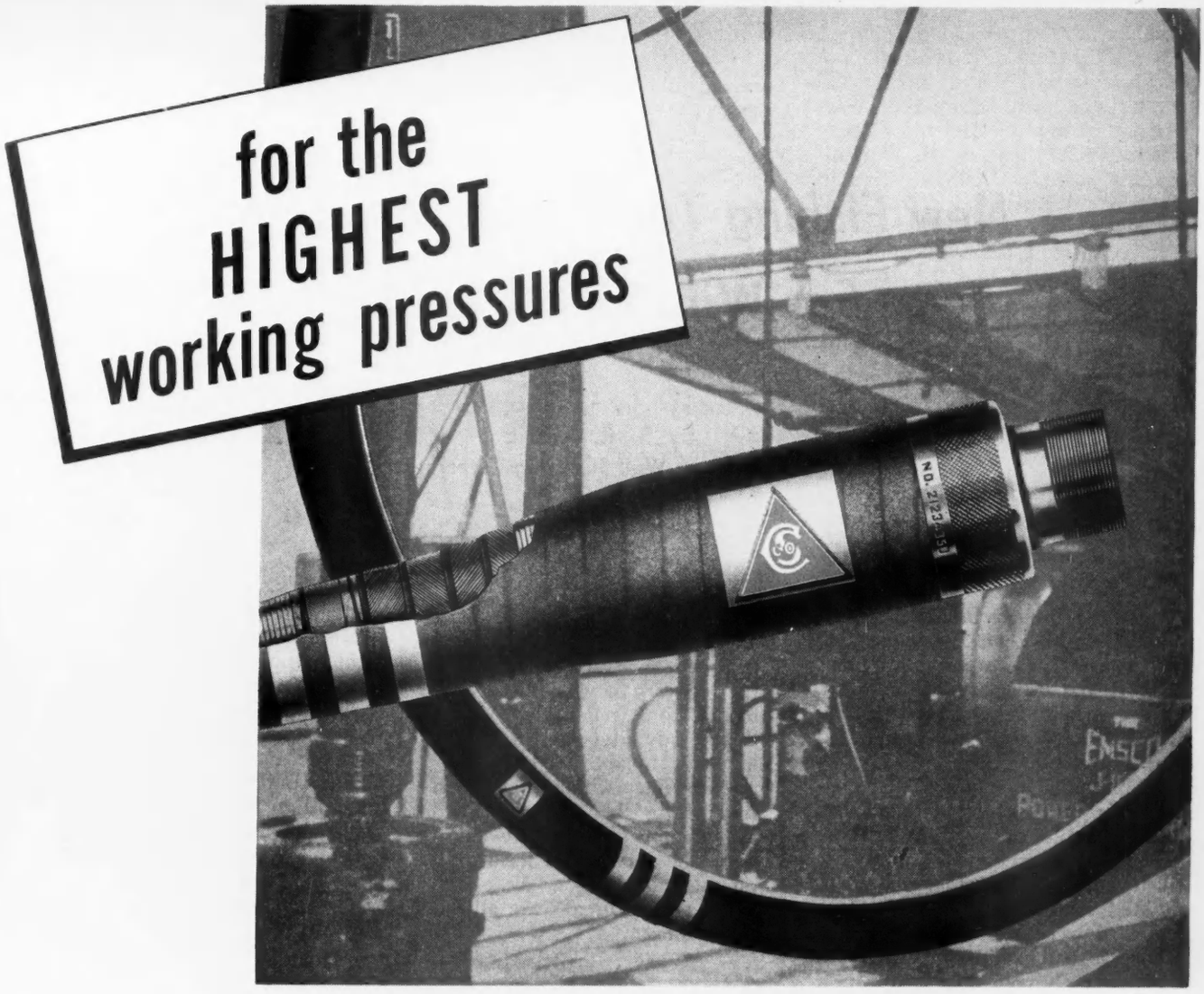
Krueger

Nowak

T. J. NOWAK, research engineer for the Union Oil Company of California, received the B.S. degree in chemical engineering from University of Wisconsin in 1944. After graduation, he was employed by The Atlantic Refining Company and, in 1946, joined Union Oil Company. During the past three years he has worked on the problem of well completion from the well productivity point of view.

—o—

R. F. KRUEGER, also research engineer for Union Oil Company of California, received his B.A. degree in physics from Ripon College in 1939 and the M.A. degree from the University of Illinois in 1941. From 1941 to 1943 he did research and development work for the Tennessee Eastman Corporation. In 1943 he transferred to the Manhattan project, serving as research engineer at the University of California and later as production superintendent at Oak Ridge. In 1946 he was employed by Douglas Aircraft Company for jet propulsion and in 1948 Krueger joined Union Oil Company for assignment on secondary recovery and well completion problems.



The sensational 3-band
GREEN TRIANGLE Rotary Hose

This remarkable new hose meets the severe requirements of today's stepped-up oil field drilling operations. Green Triangle has features and advantages never before found in a premium rotary hose.

TRUE-BALANCE CONSTRUCTION

4 plies of high-tensile steel wire provide strength, flexibility and durability. This rugged construction permits installation with all types of drilling derricks.

TROUBLE-FREE OPERATION

proved consistently safe and dependable by three years of rigorous tests on offshore, barge, deep hole, high pressure and wildcat drilling rigs. Green Triangle assures substantial "downtime" savings.

Green Triangle Rotary Hose is furnished with full-hole, built-in couplings.

NEW YORK BELTING & PACKING CO. Founded 1846 — *Over 100 years of Service to Industry*

NEW YORK BELTING & PACKING COMPANY

1 MARKET STREET, PASSAIC, NEW JERSEY

New Fishing Technique Developed For Wire Line Devices

By R. R. RIEKE
Schlumberger Well Surveying Corporation

A NEW fishing technique has been developed to recover wire line and electrical surveying equipment lost in the open hole of a drilling well. Its use has materially reduced fishing costs in such cases, has eliminated more costly fishing jobs, and has resulted in a high percentage of recovery. This new fishing method has found particular adaptability in those areas where directional holes are drilled, and in those areas of unconsolidated formations with long shale sections. In recent months, in 11 cases out of 12 such fishing jobs, the fish was completely recovered by this new technique.

THIS DESCRIBES a new tool designed to insure and expedite the recovery of wire line instruments from well bores. A particular advantage is the ability to prevent cable keyseating or release line which has been trapped in this manner. Field application of the tool eliminates the necessity of hard pulls on the cable; hence, the occurrence of line breaks are all but nonexistent.

The principal difference in the new fishing technique from previous practices lies in the manner of guiding the fishing shoe down to the fish. Instead of running the drill pipe containing the fishing shoe alongside the wire line or cable attached to the stuck instrument, the latest technique requires that the cable be cut above the rotary table and threaded through the fishing shoe and drill pipe. Equipment and procedures for accomplishing these jobs have been designed and successfully proven in practical use.

Many of the difficult fishing jobs involving wire line devices have resulted from keyseating the cable in the formation at bends, or shoulders in the hole. That keyseating does occur and cause fishing jobs of this type is illustrated by Figure 1. This is a piece of hard bentonitic sandstone containing a deep groove worn by the cable. It was found lodged around the cable just above a survey instrument when the latter was brought out of the hole during a normal operation. Fortunately, the piece was dislodged without trouble in this instance. When increased tension is applied to the cable in cases of this nature, there is danger of breaking the cable at some point between the fish and the keyseat, thereby leaving much of the cable in the open hole and resulting in a very difficult fishing job.

One common practice of recovering wire line and instruments employs a slotted overshot with a cable guide in which the pipe is lowered alongside the cable in the hole. This practice has several disadvantages. Instances have occurred wherein the cable, removed from the keyseats by the cable guide, pulled back into the keyseat behind the guide and remained stuck. In some cases, due to inadvertent rotation of the drill pipe while going into the hole, the cable has been fouled or broken off. Another danger in this method lies in pinching off the cable by the tool joints pressing against shoulders or casing shoes. The technique of threading the cable and retaining it within the drill pipe effectively eliminates these disadvantages.

FIGURE 1. A hard, bentonitic section keyseated by an electric survey line.

Details of employing this new fishing technique are relatively simple. Cable stuck in the hole is first supported by a special clamp with a tee-shaped hanger resting on the rotary table as shown in Figure 2. The cable is then cut above the rotary and threaded through the drill pipe. A spear adapter is fastened by means of a rope socket to the end of the stuck cable above the rotary, and a modified overshot fastened to the sand line. These features are illustrated in Figures 2 and 3. Should no sandline be available, the cable remaining on the survey winch truck may be substituted. The sand line is passed over the instrument sheave suspended from the crown block. Tension control is maintained through use of a regular tension measuring device on the survey truck.

A single bowl overshot is used on the drill pipe for retrieving the instru-

ment. This overshot is built with sufficient inside diameter to accommodate passage of the spear and the overshot which has been attached to the sand line.

When the first stand of drill pipe is picked up and the retrieving overshot coupled to it, the sand line is threaded through it and coupled to the spear adapter on the cable in the well. The weight of this cable is then supported by the sand line and the tee-clamp supporting it during the cutting operation is removed. The first stand can then be lowered in the hole and set in the pipe slips. To support the cable in the hole while the sand line is released and threaded through the next and succeeding stands, a special C-washer is placed around the cable on top of the pipe in the hole, and the spear adapter is lowered to rest upon it as shown in Figure 2.

When it is necessary to circulate mud during the operation, a special circulating sub is installed between the kelly and drill pipe. This sub is equipped with a bushing insert that will support the cable during the circulation of fluid through it.

Contact with the fish will, of course, be indicated by a sharp decrease on the weight indicator. Whether or not the fish is engaged may easily be determined by pulling up one or two joints and attempting to pull the cable up a corresponding distance without increasing the tension. If the tension does not increase appreciably, the fish is free; if tension does increase, the fish is still stuck.

Breaking Off Cable

The next step in the fishing operation is to break off the cable at the connection to the device, which connection is purposely made to be the weakest point. This breaking off is easily acomplished by breaking out a couple of joints of drill pipe and passing the slack cable thus obtained around a sheave suspended from the traveling block. When the cable has been broken free from the device, it may be reeled from the hole onto the winch truck, and the pipe may be pulled to remove the survey instrument.

The practicability of this new method can best be illustrated by actual cases. In a recent Texas Gulf Coast well, a side-wall coring device was stuck at 8600 feet. The hole had three whipstock settings that deviated it from the vertical as much as 14 degrees. Stretch curves on the cable indicated it to be held in a keyseat at approximately 3500 feet. The new method resulted in complete recovery. Had an attempt been made to pull off at the top of the sample taker, it was quite likely that some 5000 feet of cable would have been lost in the hole.

In a West Texas well, an attempt was made by the drillers to run open end pipe alongside the cable. This failed to release the cable, which by stretch curves, was shown to be keyseated at about 2000 feet. After this attempt failed, the new technique was followed and all equipment was removed undamaged.

Tools such as these have been assembled in complete kits with adapters to fit the various drill pipe and tubing sizes so that fishing operations may be carried out efficiently with a minimum loss of time.

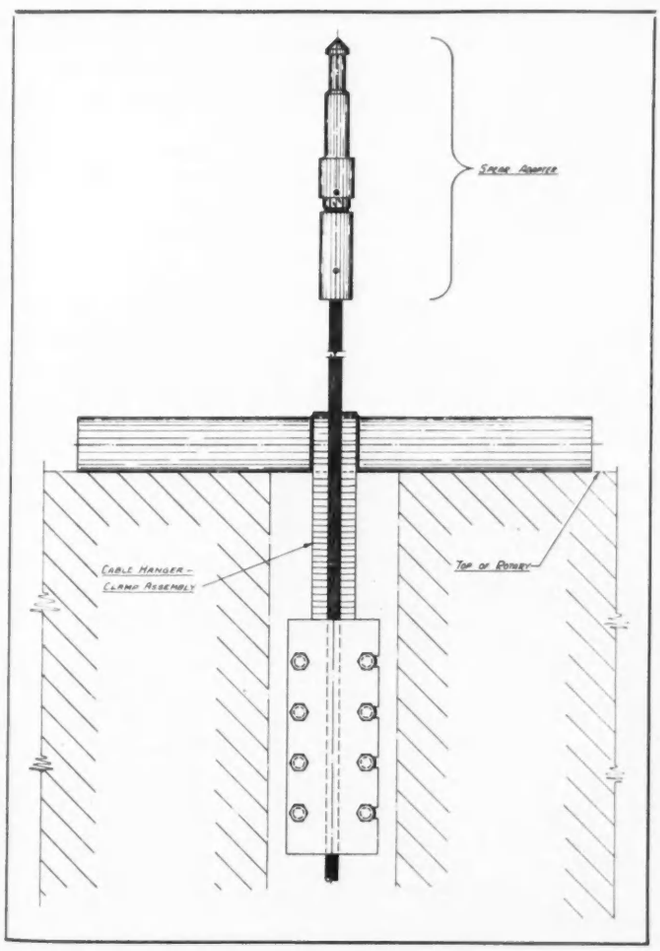


FIGURE 2. The accepted method of cutting cable and attaching spear adaptor. The cable is securely clamped in the rotary table to complete the operation.

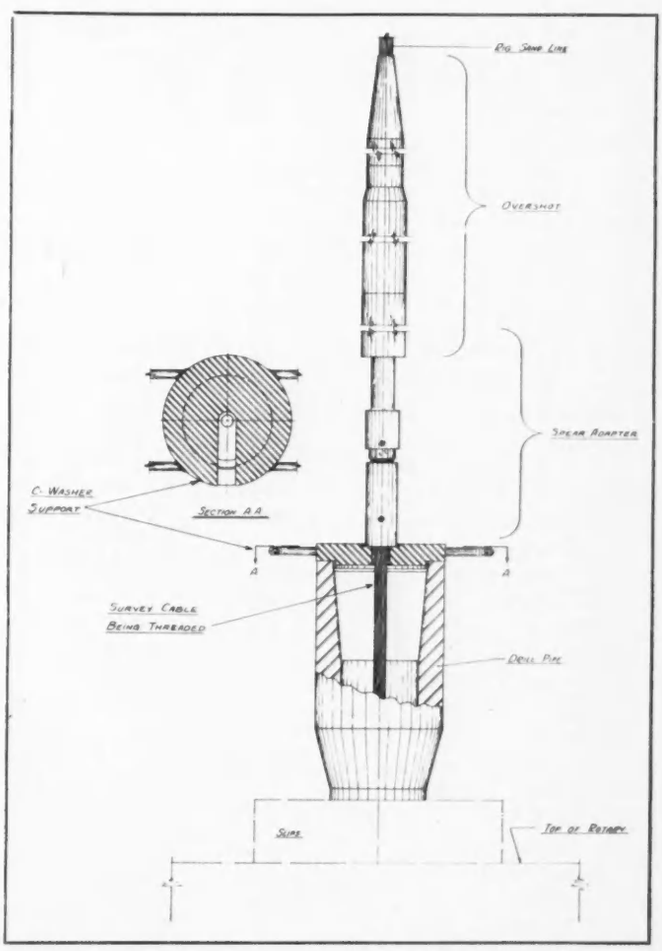


FIGURE 3. Illustrating manner in which the spear, overshot and cable are supported by the "C"-Washer. All equipment is now ready to run in hole.

Time-Dependent Strains Around Uncased Holes

By A. D. TOPPING

Assistant Professor of Engineering Mechanics
Purdue University

THE PHENOMENON of wall collapse in uncased holes is approached from a new viewpoint in this article; that the closing of the hole may be due to slow viscous or viscoelastic flow of the rock or shale. A mathematical description of such time-dependent deformation is correlated with some published observations and experiments, and the possibility that flow may be an important factor in wall collapse is demonstrated. This article is based on part of a thesis, "Elastic, Elastic-Plastic, and Viscoelastic States of Stress and Strain around a Vertical Cylindrical Hole in a Semi-Infinite Gravitational Body," submitted at the University of Illinois in partial fullfillment of the requirements for the degree of Doctor of Philosophy in Theoretical and Applied Mechanics, February, 1951.

SINCE wall collapse at the bit during drilling would cause no trouble and, in fact, would be perfectly normal, where the phenomenon is the cause of stuck drill pipe there appears to be a dependence on time. Lamar Jones, in a discussion of a paper by J. E. Warren,[1] says, "A recent survey of about 30 wells showed that in most cases, when a large amount of open hole was exposed, everything went along in fine shape for approximately three weeks, when the pipe began to stick . . ."

There are several possible explanations of this time factor. Warren's paper mentions "keyseating"; erosion by the action of the drilling fluid is another possible cause. Saunders and Topping[2] recently pointed out that the temperature stresses around an uncased hole are time dependent. Creep in rocks has been demonstrated experimentally by Griggs,[3,4] and geologists explain many phenomena by postulating viscous behavior of rock (for instance, Nettleton's theory of salt dome formation).[5] In this paper, only the latter possibility will be investigated, the rock being visualized as slowly flowing into the hole. Analysis of this situation requires some consideration of the nature of materials.

The distinction between solids and liquids is not as well defined as might be supposed; many materials exhibit properties of both. Bingham and Green[6] have shown, for example, that paint is a plastic solid and not a viscous liquid; and Beck, Nuss, and Dunn[7] have shown that the same thing is true of drilling mud. On the other hand, creep in what are apparently solids looks very like the flow of liquids because it involves deformation increasing with time. The mechanical behavior of solids is generally characterized as either elastic or plastic, and that of liquids and gases as fluid. Mechanical behavior which is neither elastic or plastic, nor fluid, has been described by a variety of names, such as elastico-viscosity, firmo-viscosity, anelasticity, transient flow and visco-elasticity; the latter term will be used here. Some of the terms mentioned are used to refer to particular kinds of viscoelastic behavior, associated with various ideal materials. To avoid confusion, the practice introduced by Reiner[8,9] of calling the ideal materials after a scientist who has studied its behavior will be followed. Models representing several such materials and curves for them showing the relation between strain and time under constant stress and their equations, are shown in Figure 1. For a more complete discussion of these, see Reiner,[8,9] Alfrey,[10] or Freudenthal.[11]

The behavior of actual materials, including rock, does not conform to that of any of these ideal materials. Griggs[3] obtained for rock in compression the empirical creep law

$$\varepsilon_1 = \varepsilon_i + mt + n \log t \qquad (1)$$

which, incidentally, has been found to apply to many other materials. Lyons[12] has shown that this equation leads to negative strains for small values of t, and should therefore be corrected to

$$\varepsilon_1 = \varepsilon_i + mt + n \log (ct + 1) \qquad (2)$$

For moderately large values of ct,

$$n \log (ct + 1) \approx n \log c + n \log t \qquad (3)$$

so that if ε_i is assumed to include (n log c), (3) reduces to (1). Lyons further points out that ε_i may be considered as an extrapolated initial strain for "The deformation at later times behaves as if its initial value were ε_i."

The creep law, (1) or (2) was obtained from uniaxial tests. Around a bore hole, a triaxial state of stress exists. In applying this creep law, therefore, it must be remembered that "simple" tension or compression is fundamentally a combination of shear and volumetric stress. To isolate the response of the material to shearing stress from its response to volumetric stress, it is convenient to put the state of stress into octahedral components; that is, components normal and parallel to the faces of an equilateral octahedron whose verteces are on the principal axes. These components have the same magnitude for each face, and therefore are the true volumetric and shearing stresses.

The stresses around the bore hole may be considered constant so long as the strains are assumed to be small, as is done here for simplicity. An analysis employing the concept of time dependent "elastic" moduli is possible when the stresses are constant.

Dividing (1) by the constant stress, σ_1, gives

$$\frac{\varepsilon_1}{\sigma_1} = \frac{\varepsilon_i}{\sigma_1} + \frac{mt}{\sigma_1} + \frac{n \log t}{\sigma_1} \qquad (4)$$

In this form, the creep law gives a reciprocal Young's modulus, or "compliance," as a function of time; that is,

$$\frac{\varepsilon_1}{\sigma_1} = \frac{1}{E(t)} \qquad (5)$$

In simple tension or compression, the octahedral shearing stress is (Freudenthal,[11] p. 176)

Just the right balance between *Precision* and *Economy!*

ROLLWAY Tru-Rol ROLLER BEARINGS

Rollway's Tru-Rol cylindrical roller bearings fill a well-defined need . . . afford the design engineer much wider latitude in his choice of means to balance performance and reasonable cost . . . help to ease the pinch on critical materials.

A steel-cage bearing in the steel-cage cost range, TRU-ROL boasts a trueness and precision of roll approaching that of bronze-separator types. That's because of the exclusive Rollway guide-lip . . . an ingenious, low-cost feature that prevents roller-skewing with all its train of evils, such as sliding friction, end-rub, power losses and excessive wear. Investigate TRU-ROL's outstanding record before you specify bearings in medium price range.

Engineering Service

Forty years of specialized bearing experience are at your service in the solving of particular bearing problems. Just ask for a Rollway engineer to consult with you. No cost. No obligation.

SALES OFFICES

Philadelphia • Boston • Pittsburgh • Cleveland • Detroit
Chicago • Houston • Los Angeles

ROLLWAY BEARING CO., Inc.
Syracuse 4, N. Y.

$$\tau = \frac{1}{3}\sqrt{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2} = \frac{\sqrt{2}}{3}\sigma_1 \qquad (6)$$

and the octahedral shearing strain is (Freudenthal,[11] p. 180)

$$\delta = \frac{2}{3}\sqrt{(\varepsilon_1-\varepsilon_2)^2+(\varepsilon_2-\varepsilon_3)^2+(\varepsilon_3-\varepsilon_1)^2} \qquad (7)$$

$$\delta = \frac{2\sqrt{2}}{3}\left[1+\nu(t)\right]\varepsilon_1 \qquad (8)$$

Here $\nu(t)$ is a time dependent Poisson's ratio.

If a time dependent shear modulus is defined by

$$G(t) = \frac{\tau}{\delta} \qquad (9)$$

(6) and (8) give

$$\frac{1}{G(t)} = \frac{2\left[1+\nu(t)\right]\varepsilon_1}{\sigma_1} \qquad (10)$$

By substituting (ref. Alfrey,[10] p. 15)

$$\nu(t) = \frac{3B(t)-2G(t)}{6B(t)+2G(t)} \qquad (11)$$

in (10), one obtains

$$\frac{1}{G(t)} = \frac{1}{E(t)}\left[\frac{9B(t)}{3B(t)+G(t)}\right] \qquad (12)$$

which reduces to

$$\frac{1}{G(t)} = \frac{3}{E(t)} - \frac{1}{3B(t)} \qquad (13)$$

or

$$G(t) = \frac{3B(t)E(t)}{9B(t)-E(t)} \qquad (14)$$

In the derivation of (13) and (14), no assumptions whatever have been made about the time dependency of any of the elastic moduli. Since there are two independent deformation components, as (13) well shows, it is obvious that the one measurement made in an ordinary creep test will not suffice to determine both. It is, however, a rheological axiom that isotropic volumetric expansion and contraction are elastic, which means that B, the bulk modulus, is constant and that creep is actually a shearing phenomenon. (This is why the laws of mechanical behavior of ideal materials are stated in terms of shear.) Since B is constant, it will often be known from the results of short time tests; and if E(t) is found from the creep test, G(t) may be determined from (13) or (14); thus,

$$\frac{1}{G(t)} = \frac{3}{\sigma_1}(\varepsilon_i + mt + n\log t) - \frac{1}{3B} \qquad (15)$$

In problems of constant stress, Alfrey[10] has shown it is possible to substitute such a time dependent compliance for the ordinary elastic modulus in the expressions for the strains obtained by the ordinary theory of elasticity.

In the case of the deep well problem, the elastic stresses are given by*:

$$\left.\begin{aligned}\sigma_r &= \frac{-p_i a^2}{r^2} + p_o\left(\frac{a^2}{r^2}-1\right)\\ \sigma_\theta &= \frac{p_i a^2}{r^2} - p_o\left(\frac{a^2}{r^2}+1\right)\\ \sigma_z &= -\rho z\end{aligned}\right\} \qquad (16)$$

where $p_o = \frac{\nu\rho z}{1-\nu}$

From a form of Hooke's law,

$$2G\varepsilon_1 = \sigma_1 - \frac{3\nu\sigma}{1+\nu} \qquad (17)$$

Whence, in view of (16), the elastic strains are

$$\varepsilon_r = \left(\frac{p_o-p_i}{2G}\right)\frac{a^2}{r^2}$$

$$\varepsilon_\theta = \left(\frac{p_i-p_o}{2G}\right)\frac{a^2}{r^2}$$

$$\varepsilon_z = \frac{p_o-\rho z}{2G} \qquad (18)$$

The radial displacement, u, is (ref. Timoshenko[14])

$$u = r\varepsilon_\theta = \left(\frac{p_i-p_o}{2G}\right)\frac{a^2}{r} \qquad (19)$$

In considering viscoelastic states of stress and strain around a deep well, it must be remembered that the state of stress in the material before the drilling of the hole depends on the viscoelastic behavior of the material. Before drilling, the vertical stress remains constant and the lateral strains are zero, and it may be assumed that these conditions have been in effect for a very long time. The lateral stresses will be assumed independent of direction.

If the material were a Maxwell body or a Burgers body, for instance, any shear stresses which may have been present would tend to relax, which means that the state of stress approaches a hydrostatic one with time. A material obeying the creep law (1) will behave similarly provided m has a positive finite value.*

After the hole has been drilled, a new state of stress exists. Disregarding any short time effects created by the passage of the drill bit, that is assuming that the hole is created instantaneously, the elastic solution above may be used as the basis of the viscoelastic analysis. The term, p_o, represents the radial pressure at a large distance from the hole—large enough that p_o is not significantly affected by the presence of the hole—and, since equilibrium is presumed to have been reached prior to the drilling of the hole, will remain constant after drilling. Since p_i and ρ may also be assumed constant, the stresses remain constant. Since the elastic constants become functions of time in a viscoelastic material, the strains are functions of time.

In general, the response of a material to a constant shear stress is

$$\delta_1 = \partial_o + \frac{\tau_1}{G(t)} \qquad (20)$$

When the initial condition is $\delta_o = 0$, it is necessary only to substitute G(t) for G in equations (18) and (19) to get the strains and displacements, G(t) being definied by an equation such as (15). There is an exception to this rule in the present problem;

* See Topping.[13] In the thesis upon part of which the present article is based, a proof is given of the applicability of thick-walled cylinder formulae to the deep well problem.

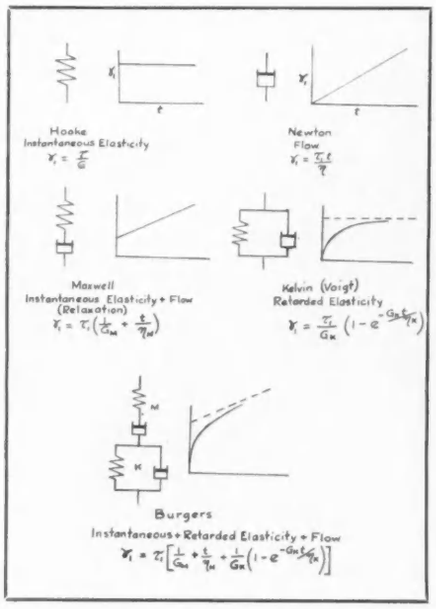
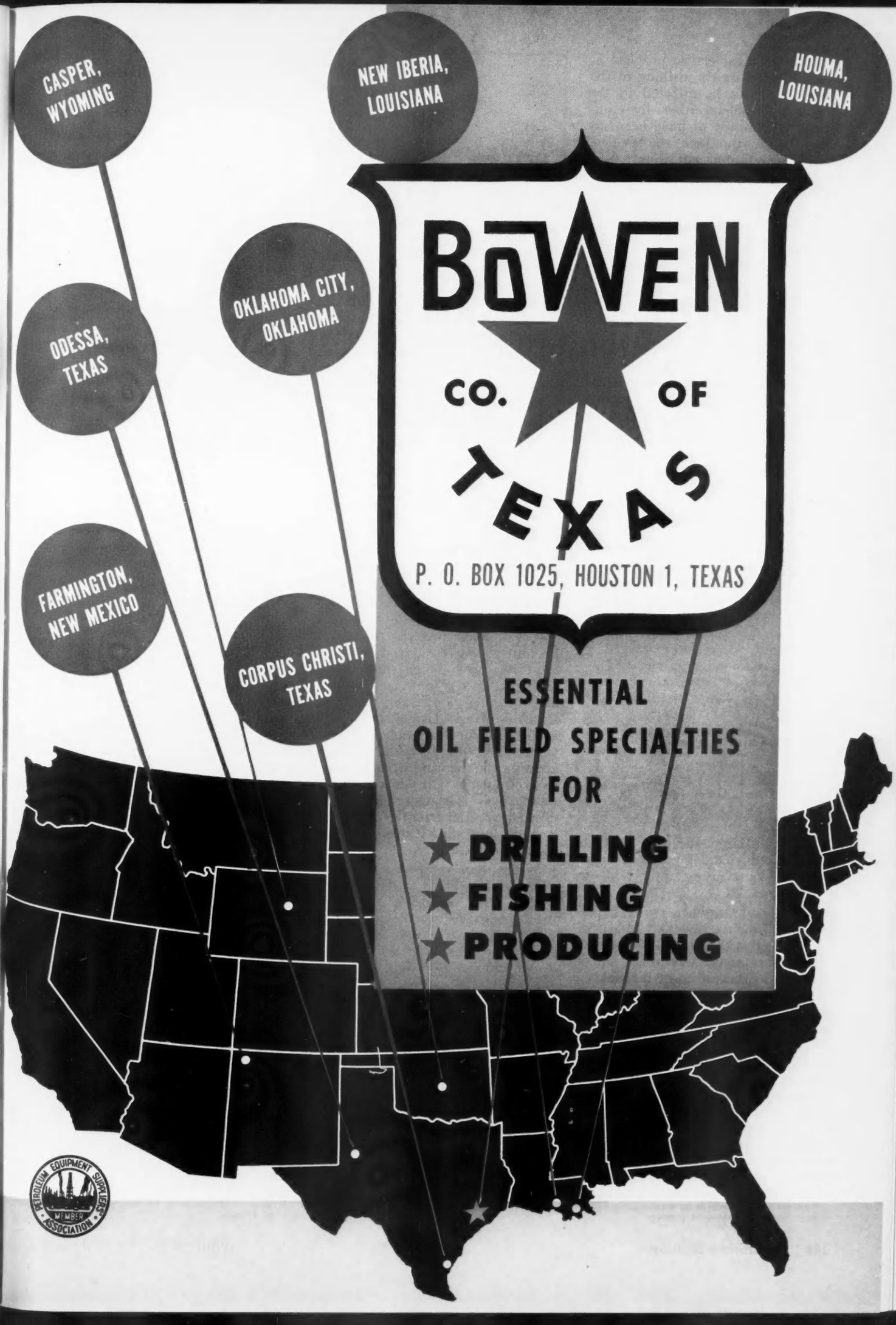


FIGURE 1. Some ideal materials.

* It is interesting to note that Westergaard[15] assumed an initially hydrostatic state of stress in his elastic and plastic solutions, but without offering any justification for the assumption.


CASPER, WYOMING
NEW IBERIA, LOUISIANA
HOUMA, LOUISIANA
BOWEN
CO. OF TEXAS
P. O. BOX 1025, HOUSTON 1, TEXAS
OKLAHOMA CITY, OKLAHOMA
ODESSA, TEXAS
FARMINGTON, NEW MEXICO
CORPUS CHRISTI, TEXAS
ESSENTIAL
OIL FIELD SPECIALTIES
FOR
★ DRILLING
★ FISHING
★ PRODUCING
PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION
MEMBER

since in the ideal elastic problem ε_z is not affected by the drilling of the hole, it will not be affected in the viscoelastic problem either, for equilibrium is assumed to have been attained before the hole was drilled. Therefore G(t) does **not** replace G in the expression for ε_z, and we have

$$\left.\begin{aligned} \varepsilon_r(t) &= \left[\frac{p_o - p_i}{2\,G(t)}\right]\frac{a^2}{r^2} \\ \varepsilon_\theta(t) &= \left[\frac{p_i - p_o}{2\,G(t)}\right]\frac{a^2}{r^2} \\ \varepsilon_z(t) &= O \\ u_a(t) &= a\left[\frac{p_i - p_o}{2\,G(t)}\right] \end{aligned}\right\} \qquad (21)$$

Here $p_o = \rho_z$.

It is instructive to compare equation (15) with the corresponding compliance for a Burgers body, which is (see Figure 1)

$$\frac{1}{G(t)} = \left[\frac{1}{G_M} + \frac{t}{\eta_M} + \frac{1}{G_K}\left(1 - e^{-G_K\,t/\eta_K}\right)\right] \qquad (22)$$

By putting

$$\left(\frac{1}{G_M} + \frac{1}{G_K}\right) = \frac{3\,\varepsilon_i}{\sigma_i} - \frac{1}{3\,B} \qquad (23)$$

and

$$\eta_M = \frac{\sigma_i}{3\,m} \qquad (24)$$

one can rewrite (15) as

$$\frac{1}{G(t)} = \left(\frac{1}{G_M} + \frac{1}{G_K}\right) + \frac{t}{\eta_M} + \frac{n}{\sigma_i}\log t \qquad (25)$$

When t is large, the term containing the coefficient of viscosity is the only one contributing appreciably to the deformation.

As an example, when z = —10,000 feet, a = 3 inches, $p_i = O$,* and $\rho = 1$ lb./ft.in.,[2] the coefficient of viscosity necessary to cause a decrease, u_a, of one inch in the radius of the hole in the three weeks suggested by Jones is, from the last of equations (21) and from (25), neglecting the first and last terms, about 2.7×10^{10}. Griggs[3] found a coefficient of viscosity for salt (halite) of 2.6×10;[17] for Solenhofen limestone of 2.2×10;[22] and for alabaster, 2×10.[18] His experiment on Conchas shale was apparently unsatisfactory, leading as it did to a negative coefficient. The quoted values are subject to reductions of several orders of magnitude (a) under high pressure—Griggs reduced the coefficient for Solenhofen limestone to around 1×10^{15} with a pressure of 10,000 atmospheres; (b) under high shearing stress—Griggs reduced the coefficient for Solenhofen limestone from 1.3×10^{15} to 2.2×10^{14} by increasing the shearing stress from 5500 to 6760 kg/cm.^{2}; (c) in the presence of solutions—Griggs reduced the coefficient for alabaster from 2×10^{18} to 8×10^{16} by testing it in water; (d) at high temperatures.

While there seem to be no actual data available for ordinary "heaving" shales, their coefficient of viscosity could very easily be less than 2.7×10^{10}; shale is known to have viscoelastic properties. Judging from Griggs' work, salt and possibly some other materials might also be expected to cause wall collapse in this way under certain conditions.

* Shown in the thesis to be a reasonable assumption from considerations on porosity.

About the Author

A. D. TOPPING, engineering specialist for Goodyear Aircraft Corporation, was graduated from Purdue University in 1939. After a short period with American Bridge Company he became instructor in mechanics at the Missouri School of Mines and Metallurgy. In 1944, he became affiliated with Goodyear Aircraft as a stress analyst and returned to Purdue University in 1947 as assistant professor of engineering and mechanics. In 1949, Topping attended the University of Illinois and received a Ph.D. in Theoretical and Applied Mechanics, February, 1951.

NOTATION

r, θ, z	Cylindrical coordinates
σ_r, σ_θ, σ_z	Normal stresses in cylindrical coordinates
ε_r, ε_θ, ε_z	Normal strains in cylindrical coordinates
ε_1, ε_2, ε_3	Principal strains
t	Time
m, n, c, ε_i	Constants
σ_1, σ_2, σ_3	Principal stresses
E	Modulus of elasticity
τ_i	Shearing stress
∂_i	Shearing strain
τ	Octahedral shearing stress
∂	Octahedral shearing strain
B	Bulk modulus
G	Shearing modulus of elasticity; modulus of rigidity
ν	Poisson's ratio
E(t), G(t), etc.	Time dependent moduli
a	Radius of hole
p_i	Internal pressure in hole
p_o	Lateral pressure at a large distance from the hole
ρ	Density of overburden, pounds per square inches per foot of depth
u	Radial displacement
u_a	Radial displacement of edge of hole
η	Coefficient of viscosity
$(\ )_M$	Subscript refers to Maxwell element
$(\ )_K$	Subscript refers to Kelvin-Voigt element

REFERENCES

[1] Warren, J. E., "Causes, Prevention, and Recovery of Stuck Drill Pipe," Drilling and Production Practice, American Petroleum Institute, p. 30-39 (1940).

[2] Saunders, K. D., and Topping, A. D., "Thermal Stresses around an Uncased Hole," World Oil, Vol. 131, No. 7, p. 167 (1950) and Vol. 132, No. 1, p. 155 (1951).

[3] Griggs, D. T., "Creep of Rocks," *Journal of Geology*, Vol. 47, p. 225-251 (1939).

[4] Griggs, D. T., "Deformation of Rocks under High Confining Pressures," *Journal of Geology*, Vol. 44, p. 544-571 (1936).

[5] Nettleton, L. L., "Recent Experimental and Geophysical Evidence of the Mechanics of Salt Dome Formation," Bulletin, American Association of Petroleum Geologists, Vol. 27, p. 51-63 (1943).

[6] Bingham, E. C., and Green, H., "Paint, a Plastic Material and not a Viscous Liquid," Proceedings, American Society for Testing Materials, II, Vol. 19, p. 640 (1919).

[7] Beck, R. W., Nuss, W. F., and Dunn, T. H., "The Flow Properties of Drilling Muds," Drilling and Production Practice, American Petroleum Institute, p. 9-22 (1947).

[8] Reiner, M., Deformation and Flow, London: H. K. Lewis & Co. (1949).

[9] Reiner, M., Twelve Lectures on Theoretical Rheology, Amsterdam North-Holland Publishing Co., and New York: Interscience Publishers, Inc. (1949) [Revised edition of Ten Lectures on Theoretical Rheology, Jerusalem: Rubin Mass (1943)].

[10] Alfrey, T., The Mechanical Behavior of High Polymers, New York: Interscience Publishers, Inc. (1948).

[11] Freudenthal, A. M., The Inelastic Behavior of Engineering Materials and Structures, New York: Wiley (1950).

[12] Lyons, W. J., "The General Relations for Flow in Solids and Their Application to the Plastic Behavior of Tire Cords," Journal of Applied Physics, Vol. 17, p. 472 (1946).

[13] Topping, A. D., "Wall Collapse in Oil Wells as a Result of Rock Stresses," World Oil, Vol. 129, No. 3, p. 112 (1949).

[14] Timoshenko, S., Theory of Elasticity, New York: McGraw-Hill (1934).

[15] Westergaard, H. M., "Plastic State of Stresses around a Deep Well," Journal, Boston Society of Engineers, Vol. 27, No. 1, p. 2 (1940).

ACKNOWLEDGMENT

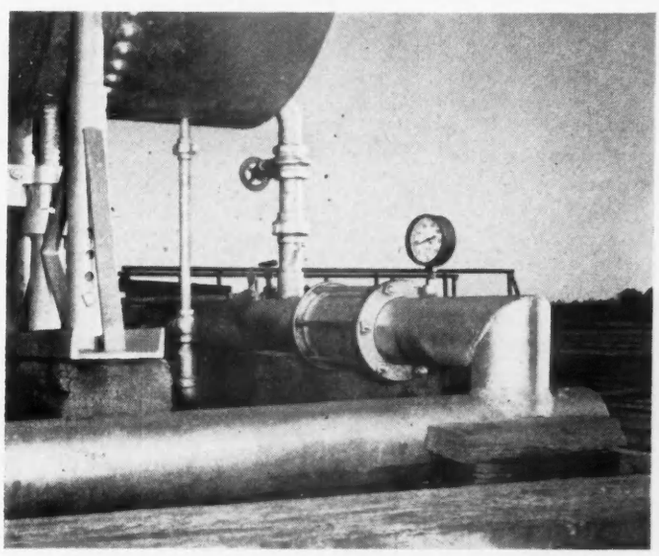
The investigation on which this paper is based was suggested by Dr. A. M. Freudenthal, of Columbia University and the University of Illinois, and carried out with the advice and encouragement of Professor J. O. Smith, of the University of Illinois.

How to do it!

DRILLING HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—*Increase Efficiency of Drilling Rig Boilers*



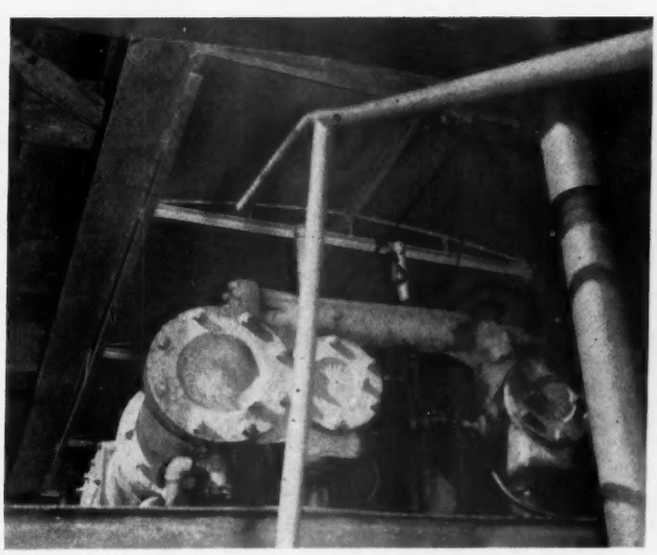
The creation of controlled pressure in the stack blower system will permit a more carefully regulated and efficient operation of oil field boilers. For the sake of increased economy, exhaust steam is generally utilized for the stack forced draft system. However, it is the usual practice to pipe steam to the blower from an open end, non-restricted exhaust manifold. In this case, the boilers have a tendency to breathe with the injection of variable exhaust pressures. The occurrence may cause an instantaneous blanketing of the burner with smoke and non-combustible gases.

A simple method of eliminating this firing problem was developed by an operator who placed a pressure gauge at the rig side of the exhaust log and a gate valve at the discharge end. With this installation it is possible to create back pressure in the manifold by adjusting the gate valve and observing the gauged pressure.

The exhaust manifold, which is constructed of seven-inch casing, acts as a large volume tank in dampening pressure pulsations existing within the system.

The observant fireman may better regulate the steam generating characteristics of the boilers by closely coordinating the back pressure on the stack blowers and the resultant vessel pressure.

HOW TO—*Prevent Corrosion of Underfloor Engines*



Underfloor engines are subject to extreme abuse in the process of washing the derrick floor and tripping wet strings of drill pipe. One operator has eliminated this condition through the installation of a metal cover which insures complete protection from mud, water and other corrosive or abrasive fluids.

The sloped roof is constructed of light gauge sheet metal with 1½-inch angle iron framing, sucker rod truss supports and telescoping two-inch legs. The edges of the roof are rolled to form a gutter which directs residue flow toward the ends of the unit. In this manner, it is not possible for fluid to drip down along the side of the engine.

The telescoping roof is lowered to the top of the engine for transport, a feature incorporated for maximum portability. This light, welded roof is so well balanced that the four supporting legs are stationed near the center of the engine base plate.

Heavy-duty, porcelain insulators are stationed on the truss supports to provide proper and safe anchorage of electric light lines. Conventional, screw-type sockets have been positioned in a manner to provide adequate lighting above the engine, a provision of tremendous advantage in case of a need for emergency repairs.

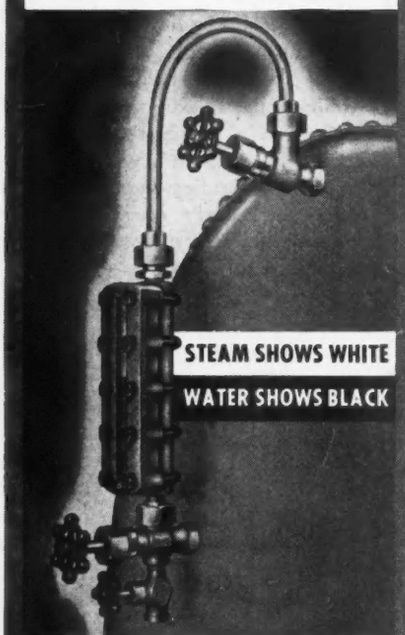
Ultimate payout of this inexpensive shelter may be seen in an assured savings of rod, packing and outboard gear expenditures.

PENBERTHY
Drilling Hints

Drilling contractors have long found that it pays to standardize on Penberthy products because of their exceptionally rugged construction and their dependable performance under the most severe operating conditions.

PENBERTHY INJECTOR

Penberthy Automatic Injectors are the accepted method of assuring an uninterrupted supply of feed water to boilers at minimum cost. They are quickly and easily installed—require little attention.

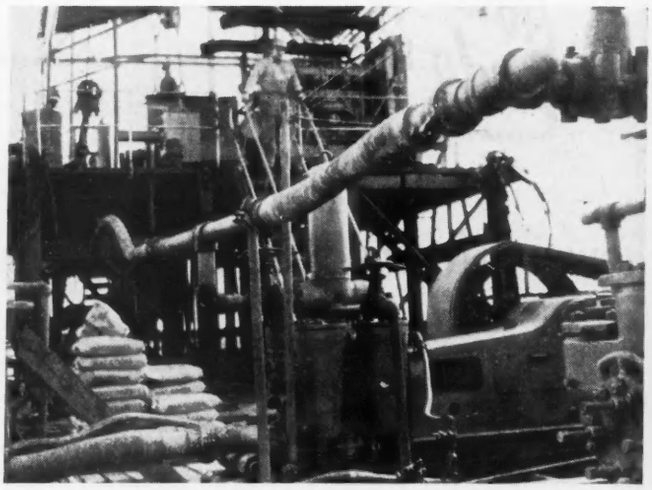


PENBERTHY "Reflex"
WATER GAGE SET

Water level cannot be misread because steam always shows white and water black. U-Bolt construction permits replacing glass by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler. 3277-D

PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant — Windsor, Ontario

HOW TO—*Elevate Flexible Mud Line*



Installation of elevated, flexible mud lines will expedite the process of rigging-up workover tools or light rigs which do not require extremely high circulating pressures. A method of applying the idea is through the installation of permanent fittings in the mud pump discharge. The fittings must be selected and installed with care so that the finished product will fall within the limits of highway load restrictions.

After the pump has been fitted with short coupled connections, rotary hose is cut to desired lengths and equipped with unioned nipple inserts. With the application of this principle, the process of rigging-up simply involves spotting the pumps with a truck and flanging the hose sections.

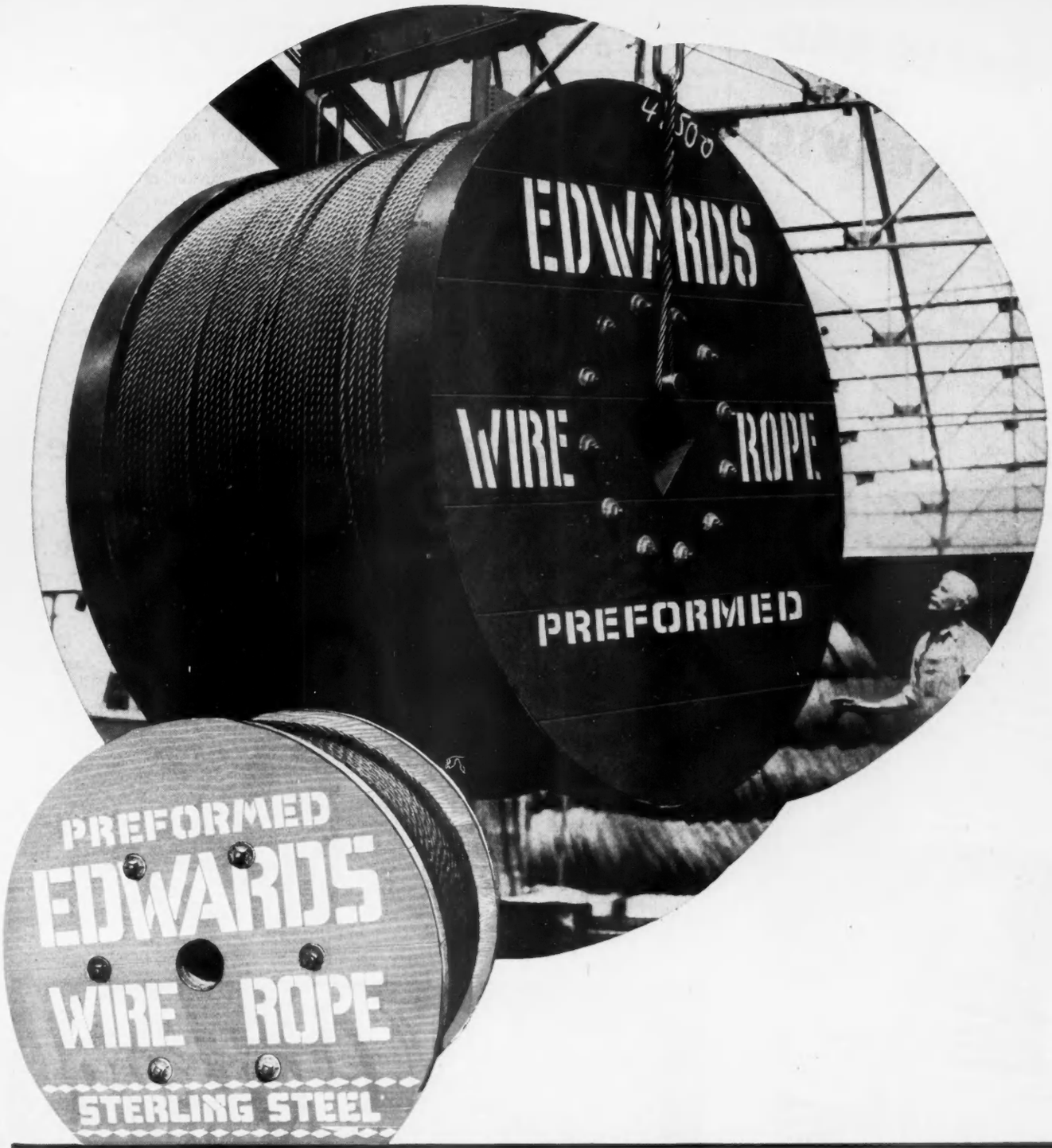
Elevation of the mud line permits a considerable saving in pipe connection expenses, assists in the elimination of friction loss factors, and permits more rapid rigup practice.

HOW TO—*Install Shale Shaker Walk*

Access to the screen side of the shale shaker can be provided by expanded metal, folding walkways equipped with chain guard rails. One operator has incorporated this feature on his rig to afford a convenient means of servicing and cleaning the shaker screen and collecting sample cuttings.

Utilization of expanded metal offers several advantages not peculiar to many other materials. Above all, the expanded metal surface may be easily cleaned and provides a safe, nonskid walking surface for rig personnel. This feature is of basic importance since mud and cuttings are continually falling on walkways attached to the shale shaker.

Construction of the walkway involves fabrication of a two-inch angle iron frame with the expanded metal welded on the under side. Plate steel brackets are then extended from the shaker unit to form a bolt hinge attached to the walkway. The one-inch supporting leg is hinged in a similar manner to the lower section of the shaker unit and fitted into a sleeve adaptor on the under side of the two-inch angle iron frame. The one-inch guard rail posts slide in pipe sleeves welded to the outer edge of the angle iron frame. Each



YOU CAN BET YOUR LIFE ON

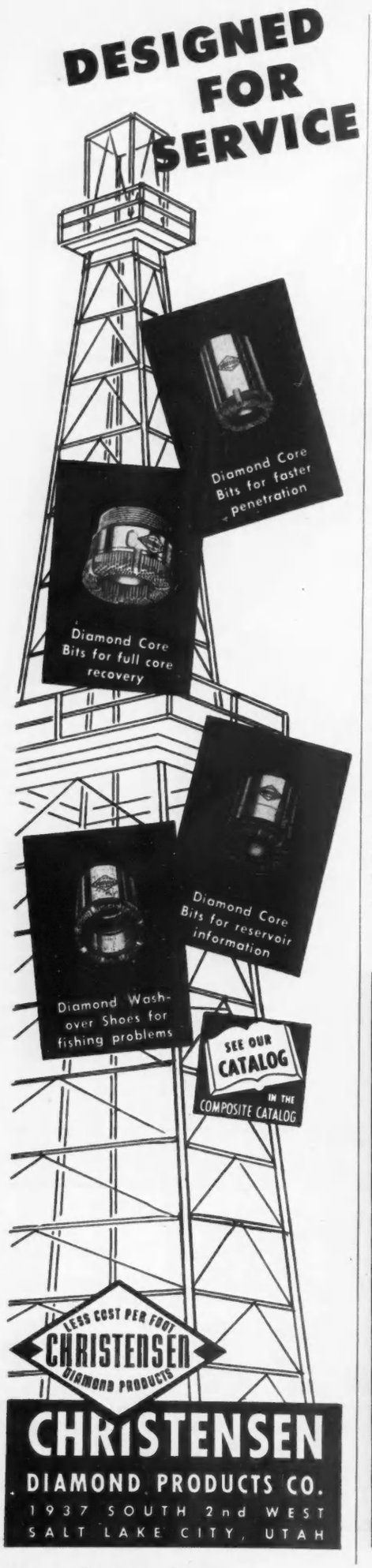
EDWARDS
WIRE ROPE

Head Office: SAN FRANCISCO • Main Plant: SOUTH SAN FRANCISCO

Branch offices

SEATTLE • PORTLAND • LOS ANGELES • HOUSTON

Distributors throughout the West, Gulf Coast and Mid Continent


DESIGNED FOR SERVICE
Diamond Core Bits for faster penetration
Diamond Core Bits for full core recovery
Diamond Core Bits for reservoir information
Diamond Wash-over Shoes for fishing problems
SEE OUR CATALOG IN THE COMPOSITE CATALOG
LESS COST PER FOOT
CHRISTENSEN
DIAMOND PRODUCTS
CHRISTENSEN
DIAMOND PRODUCTS CO.
1937 SOUTH 2nd WEST
SALT LAKE CITY, UTAH

post is equipped with hooks to support the chain guard. The walkway frame is formed to provide openings immediately below the shaker screen to permit cuttings to fall to the ground.

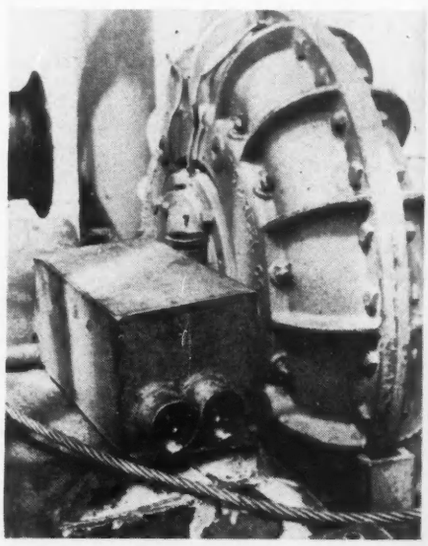
Preparation of the unit for transport simply involves removal of the guard rails, disengaging the one-inch pipe supports and allowing the hinged walkway to fall along side the shaker unit. The leg supports are held against the side of the unit by the weight of the walkway.

Outstanding advantage of the unit is primarily a safety feature. Of course, it will be more convenient for rig personnel to service the shaker unit: However, the fact that a safe, nonskid work surface is available will virtually eleminate serious accidents which often occur when personnel slip on mud around the shaker unit.

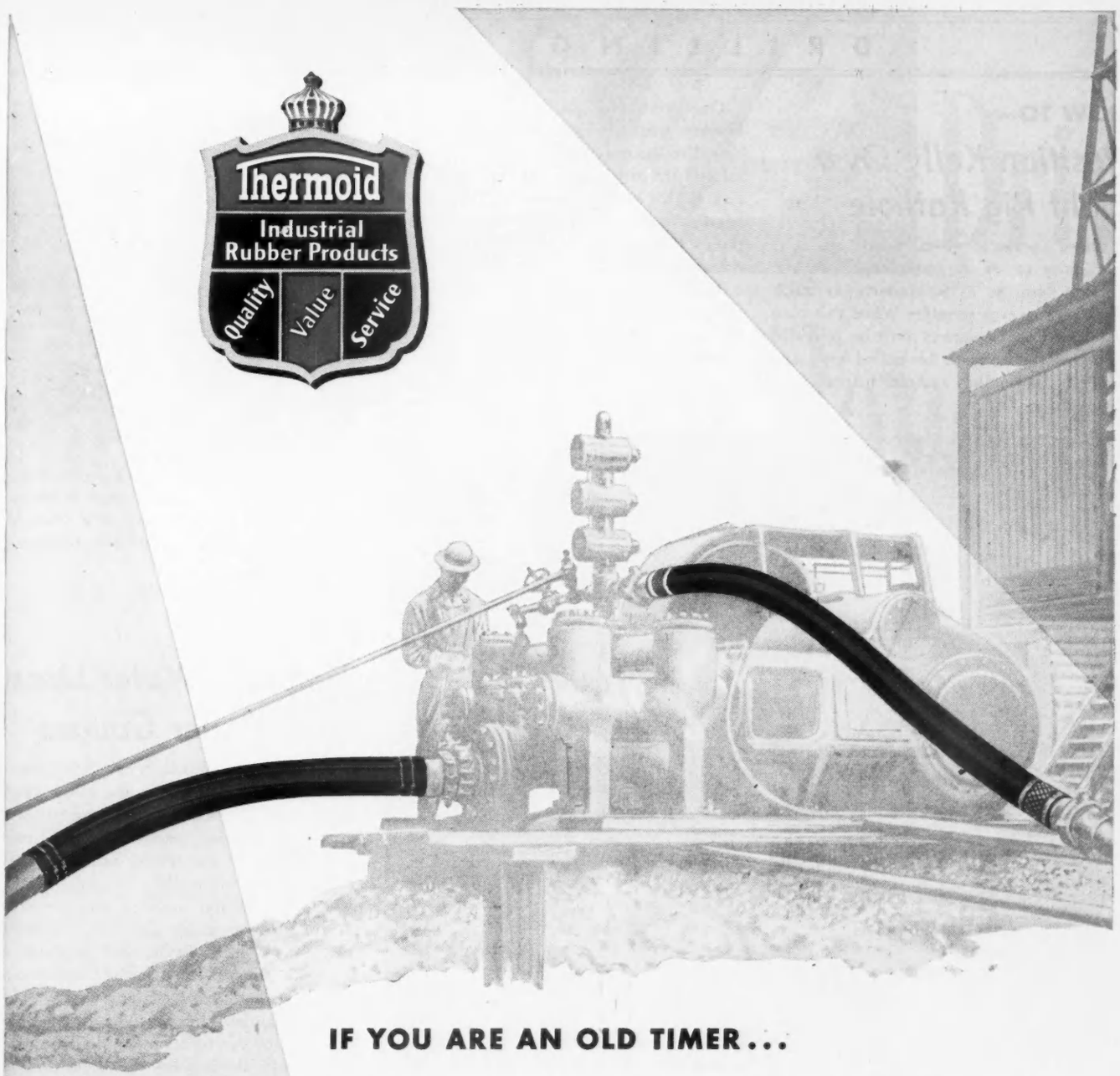
HOW TO—*Extend Rotary Chain Life*

The rotary chain, one of the more expendable and often neglected parts of a rig, can be conditioned for longer service life by means of the illustrated lubricator. A simple, welded sheet metal box, this lubricator is permanently attached to the stationary chain case bolted to the drawworks. Oil is introduced through a one-inch junk ell welded to the side of the lubricator. Brass petcocks, protected by two-inch collars, are tapped in the end of the box to adjust flow of lubricant to the rotary chain.

Oil feeding from the lubricator is gathered by a bead welded on top of the case and is allowed to drip down on the chain through two holes. Inexpensive or water-contaminated oils may be employed for the efficient lubrication of the rotary chain.



Gotkool
water cans and coolers
GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. Push-Button Faucet at slight additional cost.
GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes with Push-Button Faucet.
KEEP PURE DRINKING WATER ALWAYS HANDY
GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug-fitting, large, removable top, handy non-leaking push-button faucet. GOTT Water Cans for handy field use. Your supply store has them, get one today!
STANDARD OF THE OIL FIELDS
Insist on the Genuine
Gott
H. P. GOTT MFG. CO.
WINFIELD, KANSAS



IF YOU ARE AN OLD TIMER...

If you are an old timer in the oil fields, you have probably used Thermoid Powerflex Rotary Hose for many years. And we don't need to tell you that the name "Thermoid" on any product is a sure sign of dependability. But we would like to remind you of the time and labor saving qualities of these two Thermoid Hoses:

Thermoid Mud-Flo Suction Hose
permits raising and lowering of suction pipe and changing the position of intake without changing connections. Reinforced with heavy galvanized round wire imbedded in the walls to prevent collapse and permit unobstructed flow.

Thermoid Flexible Discharge Hose
speeds rig-up and tear-down time between mud-pump and standpipe. Eliminates vibration that causes loosened connections, and avoids sharp angles that cause pressure loss and turbulence. Full flow couplings securely anchored for the life of the hose. Steel cables provide maximum flexibility—every length pre-tested to 5000 psi.

As always, it will pay you to specify Thermoid.

Mid-continent Office and Warehouse: Houston, Texas

SEE OUR CATALOG IN THE COMPOSITE CATALOG

Thermoid

Powerflex Rotary Hose • Trioflex Slim-Hole Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • F.H.P. and Multiple V-Belts • Oil Country Flat Belting

Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All Types of Hose • Molded Specialties • Brake Blocks

Thermoid Company • Offices & Factories: Trenton, N. J., Nephi, Utah

HOW TO—
Position Kelly Over Light Rig Rathole

On a jackknife or mast-type rig it is customary to set the rathole just off the derrick floor, so as to conserve as much working space as possible. When this plan is followed, some means must be provided to allow the kelly to be pulled over and spotted above the rathole before it is lowered.

One contractor had welded a special bracket which was formed so as to be bolted to the outer side of he flange which formed the top of the rathole. An extension of this bracket, provided with an offset to give additional clearance, carries the pulley through which the pull-over line is reeved.

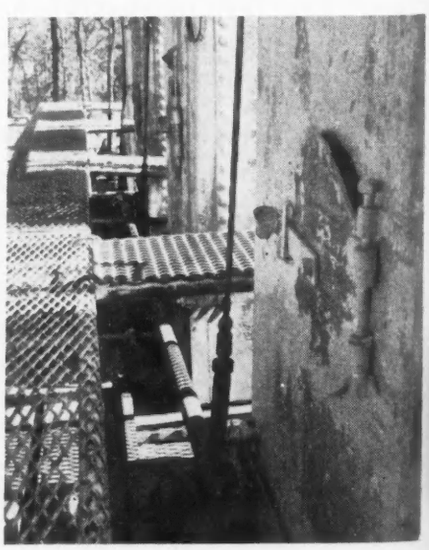
With this type of equipment, the rathole pipe can be set without its being necessary to align it in any special manner. The bracket is then bolted to the flange so as to provide the desired direction of pull. The entire bracket being outside the derrick floor, and extending outward from the rathole pipe, no interference is offered to floor work, and no handling is required to bring the kelly into proper alignment for lowering.

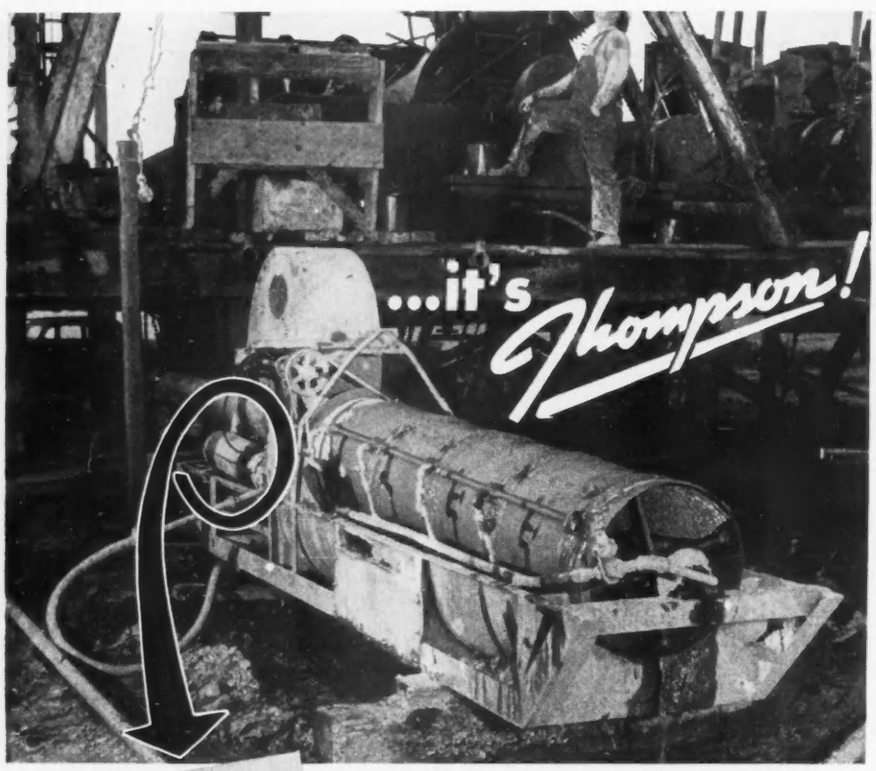
HOW TO—
Manifold Water Lines From Boiler Gauges

Water gauges on boilers can be equipped with a manifold to gather and route water away from the location. The advantages of the application predominate in barge installations or on sandy, unstable locations which wash easily.

The installation includes the extension of the ¼-inch gauge line to a 1½-inch swedge, 1½-inch nipple, and finally to a 1½-inch nipple welded in the 2-inch manifold line and fitted with a union. The 2-inch manifold line can be directed to any part of the location for fluid disposal or, it may be laid to the boiler pit in areas where water is at a premium.

A sufficient number of unions are placed in the 2-inch manifold line as an aid in rigging-up tools.





THE PIONEER OF
SELF-MOTIVATED SEPARATORS

- PROVEN PERFORMANCE
- ECONOMICAL OPERATION
- SAVES DRILLING COSTS

No drilling outfit should be without a Thompson Shale Separator and Sample Machine. The Thompson Separator does a twofold job: (1) it removes the shale and abrasives from valuable drilling mud, and (2) the amazingly accurate SAMPLE MACHINE collects cuttings all the time the separator is operating to give an accurate foot-by-foot analysis of the progress of the well. The value and accuracy of the Sample Machine is recognized by drilling and geologic authorities as the best method of obtaining samples.

Try THOMPSON, You'll See . . .
SOLD THROUGH SUPPLY STORES EVERYWHERE!

THOMPSON TOOL CO.
IOWA PARK, TEXAS

Morse HY-VO (TRADE — MARK) Drive

that "couldn't be done"!

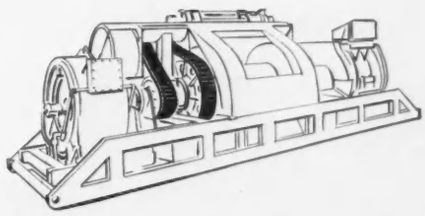
PROVIDES MEANS FOR TRANSMITTING POWER TO DRILL 20,000-FOOT HOLES . . . MAKING POSSIBLE 1500-H.P., 600-R.P.M. PORTABLE DIESEL-ELECTRIC DRAWWORKS

Experienced engineers said it "couldn't be done" with conventional chain drives.

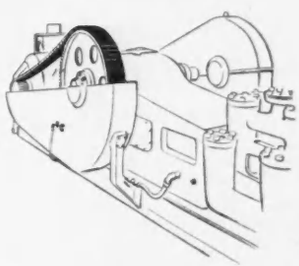
It couldn't be done, but the sensational, new Morse HY-VO Drives took the job in stride . . . an assignment requiring drives which would operate *twice as fast* with *three times the load* considered practical by manufacturers for conventional chain drives. And, the job was done with 2″-pitch, 12″-wide HY-VO Drives, allowing the unit to be *portable!*

Entirely new design principles are used in the HY-VO Drive. Vibration and destructive linear pulsations are virtually eliminated, allowing the HY-VO Drive to operate at tremendously increased rotative speeds, using drives of much narrower widths. Cost-per-hour can be cut by as much as 50 per cent; service life is much longer.

Due to the shortage of materials and production facilities, orders for HY-VO Drives must carry a priority rating at the present time.



The drawworks, designed and built by EMSCO for Standard Oil Company of California. The rig is the first *portable* unit of its size and power.



The huge mud pumps used in connection with the drawworks are equipped with 1½″-pitch, 8″-wide Morse HY-VO Drives for transmitting 765 H.P. at 1120 R.P.M.

MORSE CHAIN COMPANY
7601 Central Avenue, Dept. 246 • Detroit 8, Michigan

Branch offices serving the petroleum industry:

1312 LaBranch Avenue, P.O. Box 896, Houston, Texas
2338 Fairmount, Pittsburgh, Pennsylvania
1571 Harding Avenue, Pasadena, California

Write today for Catalog No. C-72-51.

MORSE
MECHANICAL POWER TRANSMISSION PRODUCTS
PRODUCTS OF B-W BORG-WARNER

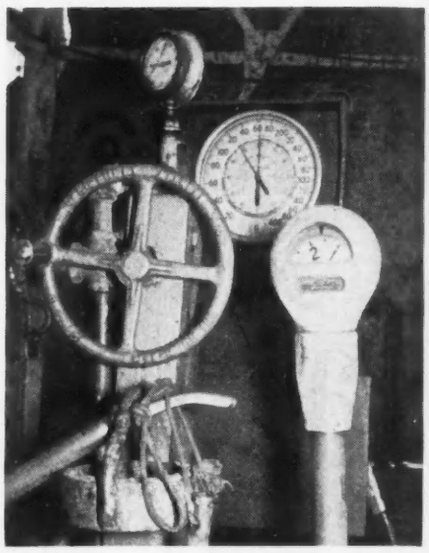
SEE OUR ADVERTISEMENT IN COMPOSITE CATALOG

HOW TO—

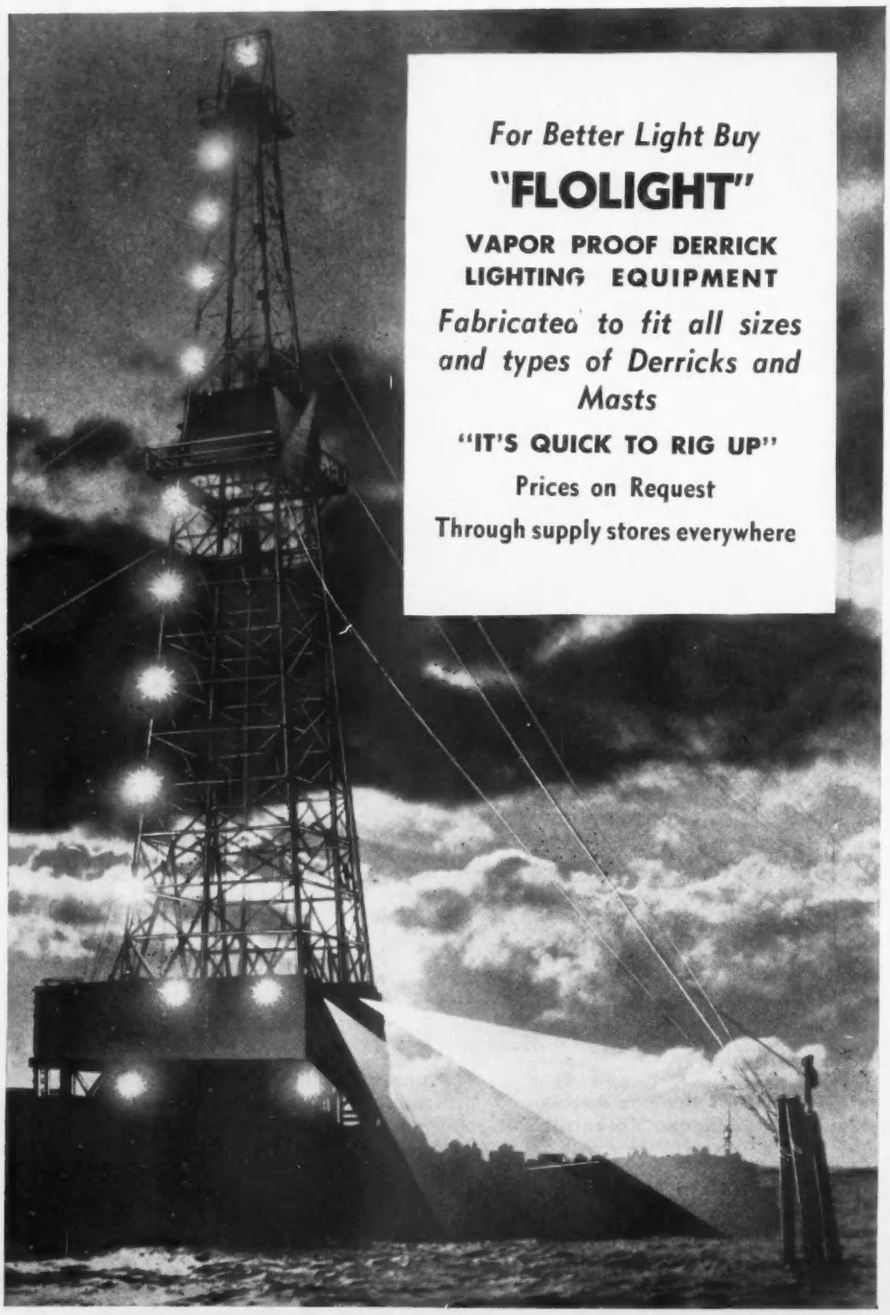
Place Mud Gauge at Driller's Position

Operation of a rig will be made easier for the driller by moving the mud pressure gauge from the standpipe corner to the drawworks. The installation involves placing a T on the standpipe feed line opposite the drill position. From that point, the only requirement is to run necessary pipe along the substructure and up through the floor. A gate valve should be connected adjacent to the standpipe line to cope with any emergency.

Outstanding advantage of the installation is that driller will have no difficulty observing mud pressure at all times. When the gauge is near the standpipe, it often is a problem for the driller to read accurately the pressure due to the distance from the drawworks plus the fact that the gauge glass is often covered with a film of mud.



In areas where loss of circulation is an ever-present possibility, the control of mud pressure is a critical operation, hence with the gauge more conveniently located, the driller will make it a habit to control the prevailing pressures with greater accuracy.


For Better Light Buy
"FLOLIGHT"
VAPOR PROOF DERRICK LIGHTING EQUIPMENT
Fabricated to fit all sizes and types of Derricks and Masts
"IT'S QUICK TO RIG UP"
Prices on Request
Through supply stores everywhere

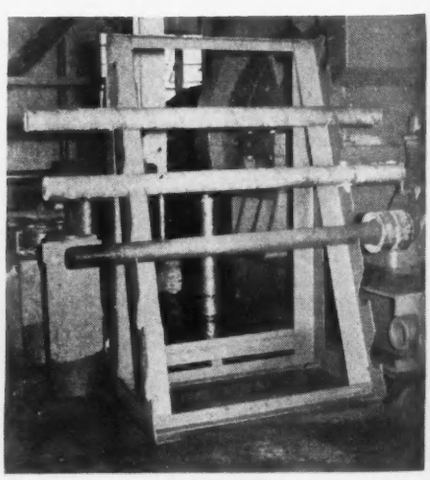
HUTCHISON MANUFACTURING COMPANY
6609 AVENUE U, HOUSTON 11, TEXAS

HOW TO—

Construct Rack for Storing Pump Rods

The rack illustrated will assist in the protection of mud pump rods from damage or corrosion and provides a method of separating different sized rods. This welded rack is made of junk derrick braces with the angled front of the frame notched to secure storage of the rods.

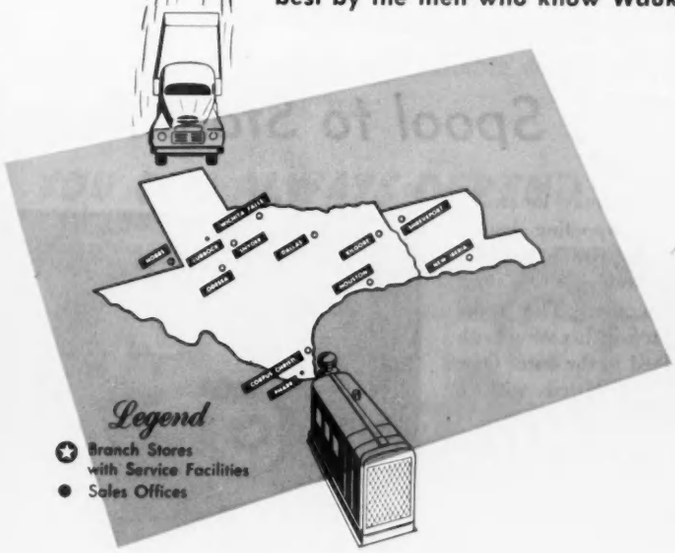
Early destruction of the polished surface may easily come from the development of rust and, as a result, the service life of the equipment is definitely limited. By storing the rods on an open rack, periodic inspection will reveal the development of damaging rust and the condition may be retarded or eliminated by proper lubrication.



YOU'RE TREATED BEST AT HOME

YOUR *Waukesha* ENGINE IS TREATED BEST AT HOME, TOO

So for service on your Waukesha Engine call Waukesha Sales and Service. You'll be sure then of getting the latest in factory-service techniques and the best in Waukesha factory-trained mechanics. Waukesha service is at your call twenty-four hours a day to help when you need it most. And to make Waukesha service fast and dependable, there are ten complete service shops strategically located in Texas, eastern New Mexico, and Louisiana. You will be treated best by the men who know Waukesha best.



WAUKESHA

SALES & SERVICE, INC.

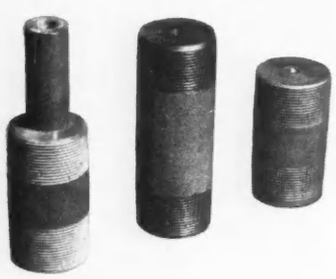
1422 MAURY STREET • HOUSTON, TEXAS

EXCLUSIVE DISTRIBUTORS FOR WAUKESHA PRODUCTS IN TEXAS, LOUISIANA AND EASTERN NEW MEXICO

LONE STAR
T. C. I.
'Jet Nipples'

Multiply Life
2 to 5 Times

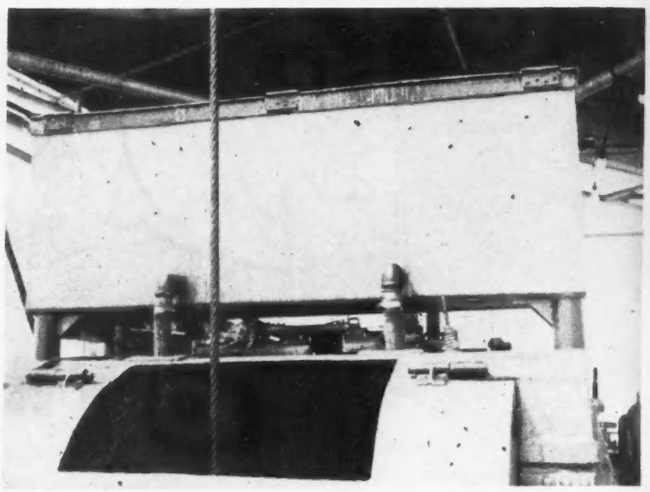
The new Lone Star TCI Jet Nipple—containing a Tungsten-Carbide Insert at the point of greatest abrasive wear—has two to five times the life of conventional jet nipples. Specify, next time, the Lone Star TCI Jet Nipple.



Lone Star manufactures a complete line of conventional and TCI Jet Nipples.

P. O. Box 848
LONE STAR TOOL CO.
WICHITA FALLS, TEXAS

HOW TO—*Cool Brake of Drawworks*



A water volume tank on top of a power drawworks will eliminate the need for an independent cooling tower and will prevent heating of the drawworks brake. Primarily adaptable to the light duty, power drawworks, this shop-fabricated tank increases rig portability, a feature of basic importance in workover and quick move operations.

Size of the cooling tank is governed by available surface atop the drawworks case. The tank should be designed to cover the maximum area available to provide a large volume of circulating water.

Rugged structural features are provided by a 1½-inch angle iron frame covered with one-tenth-inch sheet metal. A one-inch metal reinforcing strap is welded around the top edge of the tank to secure the lid hinge and latch system. The tank can be cleaned conveniently through the wide door in the top of the unit and the desired fluid level is maintained by placing a water hose through this opening.

Maximum tank cooling surface is possible by anchoring the tank to two-inch pipe legs permanently attached to the drawworks case. The pipe legs are positioned over the beam framing members of the drawworks to insure maximum support. Rigid reinforcement of the pipe legs is insured by welded steel plate brackets.

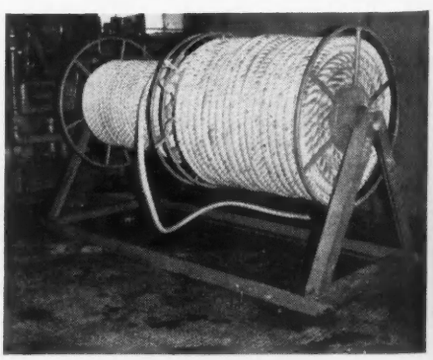
The drum side of the tank is fitted with two one-inch water outlets connected to the brake assembly by means of flexible hose and the volume of water flowing over the brake is adjusted by standard valves on the drawworks control panel. From this point, the water is gathered and pumped back to the volume tank by the conventional pump incorporated in the drawworks. Entering the tank from the top, water spills over perforated baffles to expedite rapid cooling.

This substitution of this permanently attached tank for the independent cooling tower will reduce the number of pieces of rig equipment to be handled and trucked during a move. In this manner, it is possible to amortize quickly the initial fabrication cost of this inexpensive unit.

HOW TO—*Make Spool to Store Rope*

Catline and utility rope may be stored conveniently on this dual spooling device. The skid-type base is of two-inch angle iron with the two-inch welded spool shaft housed in the top section. The spool drums are of capped, ten-inch casing with bearing journals attached to the outer face. Each bearing journal is fitted with a grease gun connection to facilitate ease of operation.

Formed sucker rod guides are welded to each end of the spool to prevent rope from dropping from the unit.



Operators everywhere rate it...

A#1

THE FIRST— AND STILL THE BEST

Old-timers remember when Baroid was introduced, more than 20 years ago, and how it made for safer, deeper, and more economical drilling. One of the outstanding things about this pioneer weight material is that operators who started using it, way back when, are still buying Baroid in preference to any other weight material. Why? Because they have found it consistently the best in high specific gravity, laboratory-controlled uniformity, freedom from grit, and in its ability to make maximum weight, minimum viscosity muds.

500 distributors make Baroid available within minutes of every active drilling area.

YOU CAN ALWAYS DEPEND ON

Baroid

BAROID SALES DIVISION
NATIONAL LEAD COMPANY
LOS ANGELES 12 · TULSA 3 · HOUSTON 2

COMPLETE DRILLING MUD SERVICE

SIMPLIFY tough PULLING jobs!

Pull Rod or Screw Is Inserted through UNIQUE "CENTER-HOLE"*
Ram plunger and is drawn in a straight, torque-free pull through Ram. Ram is its own back up! Less rigging time—more effective power!
10 to 100 ton capacities.
*"Center-Hole" in Rams of 30-ton and greater capacities.

SIMPLEX Re-Mo-Trol HYDRAULIC PULLERS

PUMPS AND REMOTE CONTROLLED RAMS

If it can be pulled, Re-Mo-Trol can pull it—easier and faster! Pulls liners, sleeves, shafts, gears, etc. SAFER remote control. Also lifts or presses. Can save its cost on a single tough job!

Simplex Jacks

WRITE FOR BULLETIN: HYDRAULIC 51

TEMPLETON, KENLY & CO.

1032 South Central Ave., Chicago 44, Illinois

KERN DIRECTIONAL DRILLING CORP.

- SIDETRACKING
- STRAIGHTENING
- CONTROL DRILLING
- CONSULTING

HOUSTON: P. O. Box 8055
Phone: KEystone 6123

ABILENE: G & L Tool Company
Phone: 5555

CORPUS CHRISTI
Specialties Warehouse
Phone: 3-4488

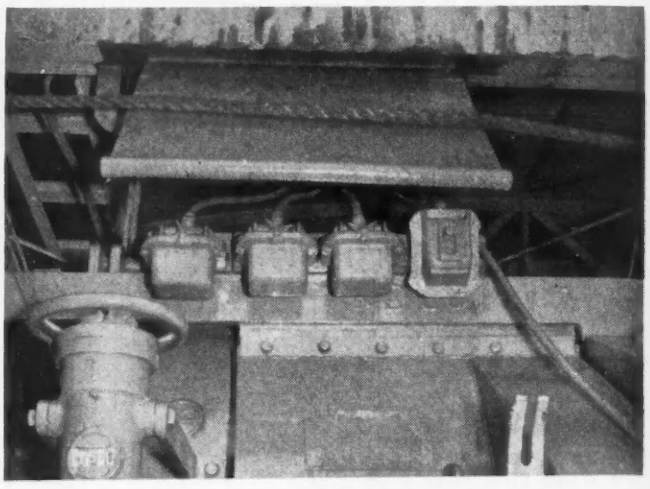
PRINTED FORMS FROM STOCK

Immediate delivery of producing and pipe line forms made from our complete line . . . Write for completely illustrated catalog.

GULF PUBLISHING CO.

P. O. Box 2608 Houston 1, Texas

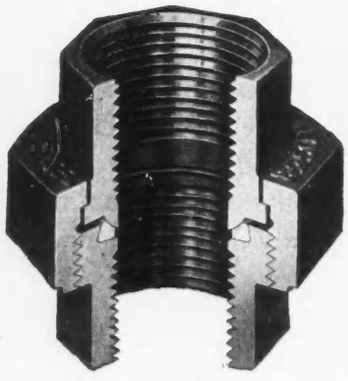
HOW TO—*Shelter Rig Control Panel*



Remote control panels can be protected from rain, rope, and falling objects by a simple sheet metal shelter. The application offers distinct advantages when the controls are stationed atop the drawworks for operating convenience. This light gauge metal shelter is reinforced with one-inch angle iron and the front edge is rolled to provide a drainage gutter. The shelter may be bolted or clamped to the bull wheel girt of the derrick, depending on existing conditions.

An example of the utility of the installation is illustrated by the rope, which would possibly damage the controls, extended over the photographed shelter. The nominal expense of the shelter is quite insignificant when compared to the cost of control repair or replacement.

Jefferson Malleable Unions



JEFFERSON'S *EXCEL* unions and union fittings available in brass-to-iron, and iron-to-iron seats. Certified Air Furnace iron used in the EXCEL line is A.S.T.M.-4733-Grade 35018 malleable, having a 53000 lb. Min. Ten.

EXCEL—
250 lb. S.W.P.—500 lb. C.W.P.

Certified Air Furnace iron produces a constant, uniform, finer grain structure union. This provides a much better iron with which to produce a positive dependable seating surface.

Unions manufactured from this malleable iron give 30% more strength; 50% more impact value; 75% more elongation. Sizes ¼" thru 3".

Obtainable through your jobber

Jefferson Union Company, Inc.

691 West 26th St.,
New York 1, New York

71 Gooding St., Lockport, New York 31 Fletcher Ave., Lexington 73, Mass.

HE'S HEADIN' FOR A HEADACHE

.....*are you?*

Nearly every design engineer has had the same experience—developed a seemingly "perfect" new machine right up to the final blue print stage only to find hidden "bugs" that spell trouble ahead.

Often these "bugs" stem from bearings—their improper or inadequate application, *THAT IS!*

Most engineers, when confronted with anti-friction problems, turn to specialists—engineers who have accumulated years of experience and "know-how" in this one field. Such is the caliber of Aetna's engineering staff. Thanks to them, leading machinery manufacturers often save months of needless time, effort and expense in product development.

If you're heading for a headache which sound anti-frictioneering can forestall, consult Aetna. Whether you require new bearings or precision parts "designed from the ground up", or merely help in selecting standard bearings, Aetna stands ready to solve your problems in the shortest possible time and at the lowest possible cost. Aetna Ball and Roller Bearing Company, 4600 Schubert Avenue, Chicago 39, Illinois.

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts

PROVED in well after well

✔ LOW COST
✔ UNIFORMITY

✔ 4 CU. FT.

1. Strata-Crete
TRADE MARK

aggregate is preferred to lighten cement slurries

Cement slurries made with Strata-Crete give these four valuable benefits — at low cost.

- **The cement slurry is substantially lightened.**
- **Higher columns of cement can be pumped with lower pressures.**
- **Excellent bridging effectiveness is provided.**
- **Perforation is facilitated.**

Strata-Crete is used with high early, slow set, or standard oil well cement. Available through leading oil well cementing concerns.

2. Strata-Seal
TRADE MARK

combats lost circulation of drilling mud

Strata-Seal has proved to be one of the most highly effective, *practical* developments to combat lost circulation and returns.

So effective is Strata-Seal's bridging action, that even in a number of extreme cases, it has restored circulation and saved abandonment of wells.

Check these advantages

- **Protects your investment.**
- **Eliminates or reduces rig down time.**
- **Savings result from ability to screen.**
- **No detrimental effect on viscosity, water content and gel strength.**
- **Easily added to mud.**
- **Does not interfere with coring operations.**

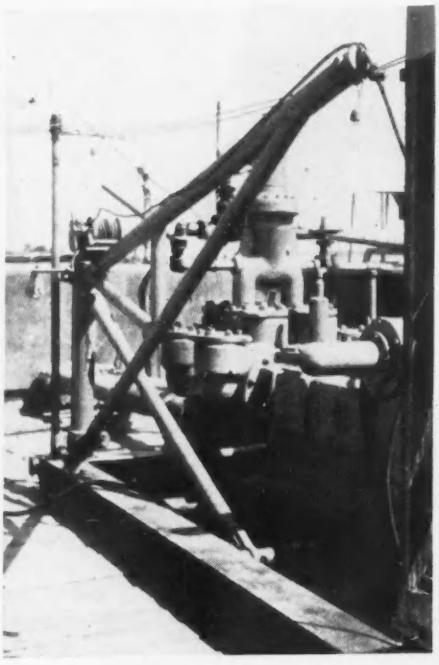
Available through leading mud service companies.

®GLC

STRATA-CRETE SALES
GREAT LAKES CORPORATION
5845 Atlantic Ave., Long Beach 5, Calif.
Sales Offices in Principal Oil Centers

DRILLING HINTS

HOW TO—
Add Suction Boom to Skid-Mounted Pump

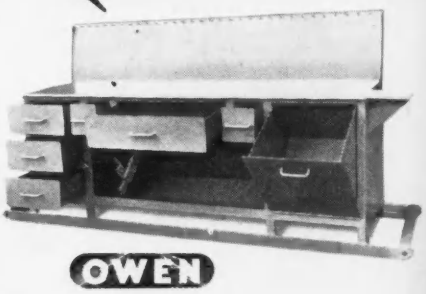


The versatility of a skid mounted mud pump can be increased by attaching a swinging suction boom so the pump can be placed in service conveniently with either mud tanks or earthen pits. The size and weight of pipe used in the boom frame depend on the specification of the pump suction.

The illustrated boom is incorporated with a unitized engine and pump hence, actual installation of the boom was less difficult due to the width of the engine skid. The master post, supporting the entire unit, is five-inch casing welded to the top of the engine skid. The pivot segment, constructed of 4½-inch casing, is housed within the master post and is equipped with a wide plate flange near the top to assist in turning the unit. The 4½-inch pipe boom, with a flush pulley end, is welded to the top of the pivot segment with a three-inch brace arm extending back to the master post. It may be noted that this brace is welded to a sliding clamp collar at the base of the master post so the boom may be locked in position for service or transport. In field service, the suction line is controled and positioned with the small, hand operated winch bolted atop the master post. Line from the winch leads over the boom pulley and hooks in the welded suction pipe eye.

Designed for supporting and adjusting the suction while a pump is in service, the boom may be employed to an advantage in the process of rigging-up and tearing down lines connected to mud tanks.

YOUR BEST BUY IN WORK BENCHES



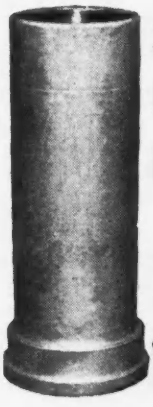
OWEN

. . . standard of the industry

These outstanding, all-steel work benches are now manufactured exclusively by Beacon Mfg. Co. Built to the same rigid specifications as set by "Whitey" Owen, they're still the best buy possible in oil field tool and work benches.

BUY OWEN Work Benches . . . manufactured by Beacon . . .through your supply store. Two sizes, to fill all requirements, are available.

L&H MACHINE WORKS
2205 Quitman Houston, Texas
EXPORT: Baird Supply Co., Inc.
420 Lexington Ave., New York, N. Y.



SLUSH PUMP LINERS RE-BORED

TO ANY STANDARD SIZE
— WE DO THE JOB —
— RIGHT! —

NEW LINER GUARANTEE
65%
OF NEW LINER COST

Our Representative
Will Be Glad to Call
Write to

WICHITA TOOL REPAIR CO.
104 Oak, P. O. Box 511
WICHITA FALLS, TEXAS

WORLD OIL

PRODUCTION SECTION

J. E. KASTROP, SECTION EDITOR

TRET·O·LITE

has long been recognized as the best buy in crude oil demulsification. This recognition has been earned by many years of practical performance, supervised by the largest staff of trained dehydrating engineers in the world. You can prove this statement easily and to your own advantage — just call your Tretolite service engineer on your next treating or corrosion problem.

TC 51-4

TRETOLITE COMPANY

SAINT LOUIS 19, MO. • LOS ANGELES 22, CALIF.

Chemicals for the petroleum industry

DEHYDRATING • DESALTING • CORROSION INHIBITION
SCALE PREVENTION • WATER DE-OILING
PARAFFIN REMOVAL

ARKANSAS
EL DORADO, Phone 3-7347
MAGNOLIA, Phone 413

CALIFORNIA
LOS ANGELES, Phone ANgelus 7247
BAKERSFIELD, Phone 3-3459
COALINGA, Phone 841
SANTA MARIA, Phone 52894
TAFT, Phone 5-4303
VENTURA, Phone Miller 3-5203

ILLINOIS
CARMI, Phone 6449
MT. VERNON, Phone 227
OLNEY, Phone 1036

KANSAS
GREAT BEND, Phone 5321 or 3740
HAYS, Phone 217
McPHERSON, Phone 1775
PRATT, Phone 1196
RUSSELL, Phone 824
WICHITA, Phone 4-8314
YATES CENTER, Phone 650

KENTUCKY
COVINGTON, Phone JU-8277
HENDERSON, Phone 4354

LOUISIANA
HOUMA, Phone 7220
JENA, Phone 376
LAFAYETTE, Phone 1170
MONROE, Phone 10597
NEW ORLEANS, Phone VA-6598

MICHIGAN
MT. PLEASANT, 31-141 or 24-863

MISSISSIPPI
JACKSON, Phone 2-6337
McCOMB, Phone 2184

MISSOURI
ST. LOUIS, Phone RE-3500

MONTANA
BILLINGS, Phone 9-4422

NEW MEXICO
HOBBS, Phone 449

OHIO
OBERLIN, Phone 495

OKLAHOMA
ADA, Phone 1179
ARDMORE, Phone 1792
DUNCAN, Phone 487
OKLAHOMA CITY, Phone 9-5424 or 5-0188
SHAWNEE, Phone 3693
TULSA, Phone 2-1133
WEWOKA, Phone 488

TEXAS
ALICE, Phone 503
AMARILLO, Phone 8935
BEAUMONT, Phone 2-1522
BIG SPRINGS, Phone 466
CONROE, Phone 1624-J2
CORPUS CHRISTI, Phone 4-6927 or 2-4081
DALLAS, Phone RI-4530
EL CAMPO, Phone 918
HOUSTON, Phone WO 7457
KINGSVILLE, Phone 1336
LEVELLAND, Phone 865-W
LONGVIEW, Phone 803, 4864 or 2472-J
MIDLAND, Phone 3185
ODESSA, Phone 3111
PORT ARTHUR, Phone 2-9769
SAN ANTONIO, Phone CA-9871
SEMINOLE, Phone 605
TYLER, Phone 4-8338
WICHITA FALLS, Phone 2-1312 or 8242

WYOMING
CASPER, Phone 2006
CODY, Phone 1197-J

CANADA
CALGARY, Phone 23546
EDMONTON, Phone 25803

SOUTH AMERICA
CARACAS, VENEZUELA, Phone 31072

Every Advantage for Successful Cementing

LARKIN GEYSER SHOE

1
Made of tough seamless forging.

2
Furnished with any thread desired.

3
High strength, scientifically cured red granite concrete.

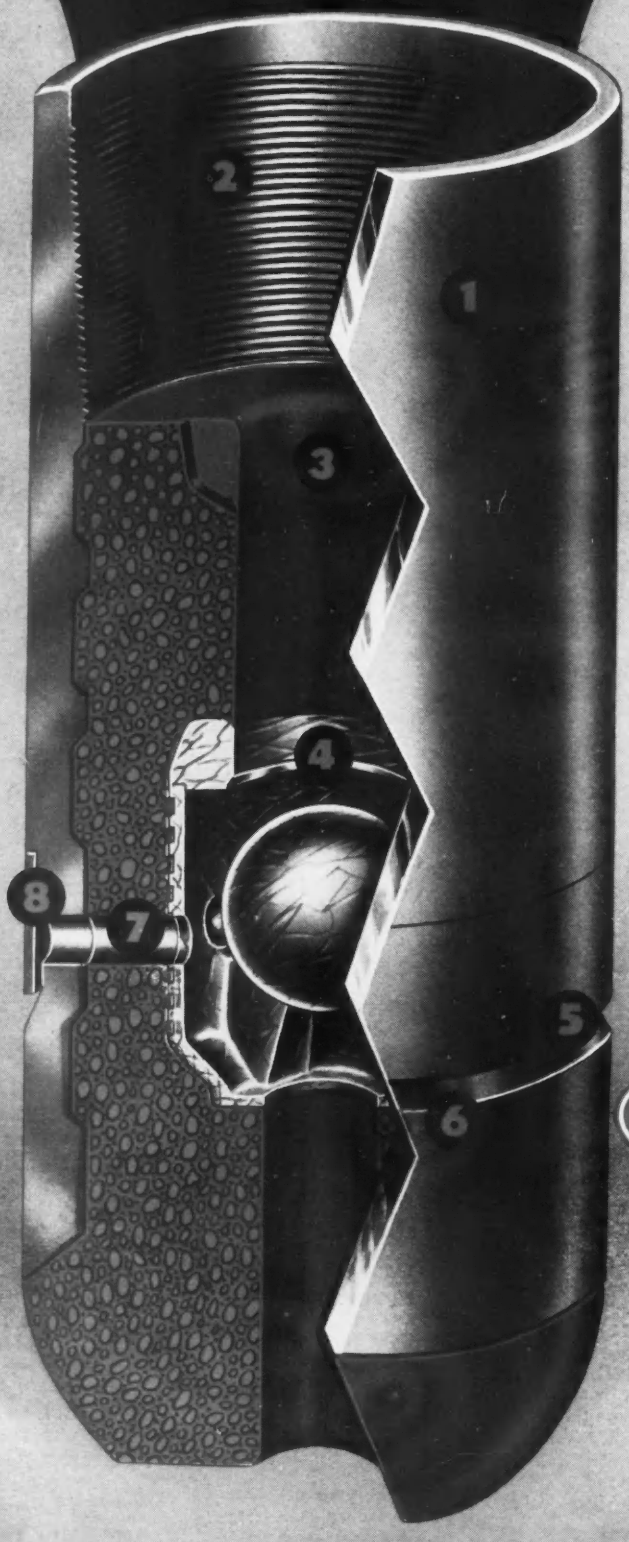
4
Superior all-Bakelite back pressure valve. Concave valve seat is lapped to fit perfectly the contour of the ball. Valve seals immediately against high or low pressures and is stronger than the collapse strength of the casing.

5
Geyser action discharges slurry around the entire periphery of the shoe to assure an even distribution of cement and to minimize channeling.

6
Geyser action up or down.

7
Eight large discharge ports provide unrestricted flow into the peripheral discharge area.

8
Single baffle plate provides powerful 360 degree jetting action.



The Larkin-Field-Proved Shoe design has won in field after field the reputation of doing *all* that a cementing shoe can do to contribute to a successful cementing job. Specify Larkin Geyser Shoes and Collars on your next cementing job. They are sold ". . . through your Supply Store."

LARKIN

...Through Your Supply Store

LARKIN PACKER COMPANY, INC.
ST. LOUIS, MO.

Value of Agents to Control Silicate Swelling in Acidizing

By DR. PAUL H. CARDWELL
Dowell Incorporated, Tulsa

VARIOUS formations from which oil and gas are produced are not completely soluble in hydrochloric acid solutions. Some of the acid insoluble materials often found in these formations are clay minerals which may be classified as montmorillonite-beidellite, kaolin and illite. These particular materials can swell during an acid treatment, reducing the benefits to be derived from the acidizing. The amount of swelling of the clays depends upon their location within the formation, on adsorption of water, on base exchange and on the effect of pH change brought about by the neutralization of the acid.

It is possible to reduce the amount of swelling of clays by the use of silicate swelling control agents. The value of this reduction in swelling is to reduce the emulsion or base sediment content of the produced oil, to increase the permeability of the formation and to make for an easier return of the spent acid from the formation.

Numerous oil wells have been treated with acid solutions containing silicate swelling control agents. In general the results of these treatments have been very good. In some cases wells which heretofore have not responded to acid have been successfully acidized by the use of the silicate swelling control agents.

It long has been recognized that certain materials found in the various limestone and dolomite formations are insoluble in hydrochloric acid solutions. But it has been only recently that these acid insoluble materials, quartz, anhydrite and numerous silicates of various types, have been given consideration in the planning of acidizing treatments.

The reason for considering the acid insoluble materials is that there is a possibility of such materials reducing the benefits which should be derived from the acidizing process. The insoluble materials seldom will reduce the permeability of an acidized section to that which it was previous to acidizing, but they can reduce the permeability from a small amount to enough to counteract completely the value of the acid treatment.

One of the first methods to take into consideration the insoluble materials was that of the use of 7.5 percent hydrochloric acid solutions instead of 15 percent solutions for acidizing limestone and dolomite formations. The idea behind the use of the weaker concentration of acid was that there would be a smaller amount of insoluble material in the spent acid solution, thus a more effective removal of these materials from the well should be obtained. This seems logical because spent solutions from 7.5 percent acid will contain only half the quantity of insolubles contained by those of 15 percent acid. Probably this is one of the reasons why such an acid solution has been more effective than 15 percent acid in the acidizing of certain oil and gas formations.

To obtain the maximum benefits from acidizing, it is important that any reduction in permeability of the formation by insoluble materials be kept to a minimum. Of these materials the insoluble silicates are extremely harmful. However, the swelling of silicates can be controlled through the use of chemical agents, a recent development. This paper is concerned with the properties of acid solutions containing such agents, the value of these agents in acidizing and the results obtained through their use in acidizing various formations.

RESULTS OF field and laboratory investigations into the problems of acidizing formations containing clay materials are discussed by the author, who describes the effect of agents used to control swelling of the silicates. The three possible changes that clay materials undergo, the composition of many different oil producing formations, and an evaluation of control agents are outlined. This paper was first presented at the spring meeting of the Mid-Continent District, API Division of Production, at Amarillo, Texas.

Acid Insoluble Materials

The chemical composition of limestone and dolomite formations varies considerably from one locality to another, in fact marked changes in composition often are found at different depths within the same formation. In Table 1 are given the chemical analyses of various oil-bearing formations as determined by x-ray diffraction. The materials included in this table which are insoluble in hydrochloric acid solutions are: (1) the x-ray unidentifiable amorphous silicates, (2) illite, (3) feldspar type minerals, (4) anhydrite and (5) alpha quartz. The major constituents of the amorphous silicates are the clay minerals which may be classified into the three groups: (1) montmorillonite-beidellite, (2) kaolin and (3) illite.

The clay materials are important from the standpoint of acidizing in that they possess the property of being able to change their swelling charac-

teristics in accordance with any change in their environment, and a change in environment is brought about by acidizing. The effect of this new environment can change the swelling of the clay particles by one or all of the following methods: (1) by increasing the amount of water adsorbed, (2) by means of base exchange and (3) by a change in pH of the clay.

Acidizing Changes Clay Environment

Location of Clays—The various clays are found in one of two places in oil-bearing formations. The clay particles may be completely enclosed by the limestone or dolomite as an integral part of the formation and in such a state are not exposed to the fluids of the well. They also may be present in fractures and in the flow channels, in which places they are exposed to the well fluids. These clays may either be a part of the formation or have infiltered into the formation. This latter state is accomplished by the clays being carried along with the brine and the oil, or deposited from drilling mud.

Adsorption of Water—The formation-enclosed clay particles will become exposed to water during acidizing of a well when the acid dissolves away the limestone and dolomite which surrounds them. The amount that such particles will swell depends upon the quantity and type of water previously adsorbed by the particles, during the geological formation of the oil-bearing section. Those particles which already have adsorbed their maximum amount of water will not take up any more, thus will not increase in volume when contacted by acid. The particles which do not contain their maximum amount of water will adsorb an additional amount on contact by acid, resulting in an increase in their volume.

These enclosed clay particles can take up water in three manners,[1] namely as crystal water, broken-bond water and planar water. Crystal water is that which is an integral part of the structural unit of the clay. This water is very firmly held and can be driven off only at temperatures of 550° to 600° C. for the kaolins; 500° to 650° C. for the illites, and 600° to 700° C. for the montmorillonite-beidellites.

Broken-bond water is that which becomes adsorbed at the corners and broken edges of the clay particles in order to satisfy electrical charges in these positions. While crystal water is held far more tenaciously than broken-bond water, in some cases it may require temperatures as high as 300° C. to drive off the broken-bond type. Most of the adsorbed water of the illites is believed to be broken-bond water.

Planar water is that which is adsorbed on the surface of the structural clay units and, as a result, pries the crystals apart. This type of water accounts to a large degree for the considerable amount of swelling exhibited by various clay materials. Individual structural sheets of the montmorillonite-beidellites are pried apart by planar water much more readily than in the cose of illites or the kaolins and therefore swell to a greater degree.

There is considerable laboratory evidence of the adsorption of water from acid solution by the formation-enclosed clay particles. Laboratory tests on oil-bearing limestone and dolomite formations occasionally show cores into which water can be forced with seemingly little change in permeability of the cores. However once the acid contacts these same cores the permeability is reduced materially. When this happens the cores usually contain the clay materials indicating that once the acid removes the limestone and dolomite, exposing the enclosed clay particles, swelling takes place which in turn decreases the permeability of the cores.

The clay particles which are within the fractures and flow channels of the formation are in contact with the interstitial water. It would be expected, then, that these particles already will have adsorbed approximately their maximum amount of water. Actually these clay particles may adsorb additional small quantities of water, especially if they have not taken up their requirements from the interstitial water. In any case, however, the amount of swelling from adsorption of water by these clays upon contact with acid will be very small.

Base Exchange—The swelling characteristics of clays also depend upon their base exchange properties[2, 3, 4, 5] in addition to the type and amount of water adsorbed. Clays can adsorb certain metallic cations such as sodium, potassium, calcium, magnesium and hydrogen, from water solutions. In the clays there is a greater attraction for some cations than for others with the result that, under certain conditions, a cation of lesser attraction which already is adsorbed upon the clay particle may be discarded in favor of a cation which is present in the surrounding solution media.[1] This particular property is base exchange, whereby there is a cation-for-cation exchange between a surrounding solution which carries the cation and the clay particle adsorbed cation.[6]

When acid contacts a clay particle there will be a base exchange occur-

TABLE 1
Chemical Composition of Various Formations

FORMATION	Depth	POOL and LOCATION	Dolomite (Percent)	Limestone (Percent)	Amorphous Silicates Unidentifiable (Percent)	Illite (Percent)	Feldspar Type Minerals (Percent)	Alpha Quartz (Percent)	Anhydrite (Percent)
Arbuckle	3447	West Boyd, Kansas	60	....	10	....	10	20	....
Brown Dolomite	3146	West Pampa, Texas	55	....	....	....	5	....	40
Brown Dolomite	3299	West Pampa, Texas	80	....	....	....	10	5	5
Caddo	3868	Daly Caddo, Texas	....	90	....	....	5	5	....
Caddo	3883	Daly Caddo, Texas	....	90	5	....	....	....	5
Caddo	3922	Daly Caddo, Texas	15	65	....	10	....	10	....
Clear Fork	5555	Goldsmith, Texas	70	....	10	....	....	10	10
Clear Fork	5680	Goldsmith, Texas	80	....	5	....	....	10	5
Clear Fork	5815	Smyer, Texas	75	....	....	....	....	....	25
Clear Fork	5920	Smyer, Texas	80	....	....	....	....	5	15
Clear Fork	7200	Flanagan, Texas	80	....	5	....	....	5	10
Ft. Riley-Upper	2555	Hugoton, Texas	....	80	....	10	....	5	5
Grayburg	1750	Shannon Ridge, Texas	60	....	....	....	....	35	5
Grayburg	3610	C-Bar, Texas	60	20	....	10	....	5	5
Herrington	3063	Hugoton, Texas	....	80	5	....	10	5	....
Krider-Lower	3253	Hugoton, Texas	80	....	....	....	5	10	5
Krider-Upper	3123	Hugoton, Texas	....	90	5	....	5	....	....
Panhandle Dolomite	2540	Panhandle-White Deer, Texas	30	....	10	....	....	....	60
Panhandle Dolomite	2640	Panhandle-White Deer, Texas	50	....	15	....	....	35	....
Panhandle Dolomite	2680	Panhandle-White Deer, Texas	70	....	10	....	....	20	....
Panhandle Dolomite	2900	Panhandle-Borger, Texas	45	....	....	....	....	20	35
Panhandle Dolomite	2935	Panhandle-Borger, Texas	75	....	....	....	....	....	25
Panhandle Dolomite	3078	Panhandle-Watkins, Texas	75	....	....	....	....	5	20
San Andres	4750	Levelland, Texas	30	....	....	....	....	10	60
San Andres	4850	Levelland, Texas	80	....	15	....	....	5	....
Winfield	3313	Hugoton, Texas	80	....	....	....	5	10	5

rence in which the hydrogen cation of the acid will exchange for the metallic cation attached to the clay. The metallic cations present on the clay particle usually will be those of sodium, potassium, calcium and magnesium. The amount of each of these various metallic cations attached to the clay particles depends upon the environment to which the clay was exposed just prior to being contacted by the acid. If that environment happened to have been brine, then the cations attached to the clay will be those present in the brine. Likewise, the clay particles enclosed within the limestone and dolomite crystals will have cations which were present in the water during the deposition of the formation.

Since there is a greater attraction between the hydrogen cations of the acid solution and the clay particles than between the clay particles and any of the normally adsorbed metallic cations, base exchange will take place forming hydrogen clays. This conversion to hydrogen clays will bring about a flocculation, or a decrease in volume of the clay particles.

Effect of pH Change and Neutralization of Acid—During the acidizing of a formation the clay particles encounter still another change in environment which is that brought about by neutralization of the acid. In this environment there are two things taking place concurrently. These are the changing pH of the acid solution and the effect of base exchange of the clay in which calcium and magnesium are replacing the hydrogen adsorbed on the clays. The effect of changing pH is to reduce the volume of the clay slightly until a pH of 2.5 to 3.5 is reached. As illustrated in Figure 1 this is the point of minimum swelling and is also the iso-electric point of the clay. The clay mineral used in the tests for Figure 1 was composed of 50 percent illite, 20 percent amorphous silicates and 30 percent quartz. Further spending of the acid to that of spent acid of pH 5.0 to 5.5 will, as far as pH is concerned, bring about an increase in swelling of the clay.

During this change in acid concentration there is taking place either base exchange in which the calcium obtained by the acid reacting on limestone is replacing the hydrogen adsorbed by the clay; or base exchange in which calcium and magnesium obtained by the acid reacting on dolomite are replacing the hydrogen adsorbed by the clay. The effect of this is to form a calcium or magnesium clay, either of which causes a reswelling of the clay particles.

Combination of two factors, the effect of pH change and of base exchange, taking place simultaneously, is to bring about a point at which the clay particle will be at its state of minimum swelling during the conversion of the hydrogen clay over to a calcium or magnesium clay. This point varies slightly with different clays.

The effect of both pH and base exchange is illustrated by the graph in Figure 2. The clay material from which these results were obtained was composed of 60 percent silicates (montmorillonite-beidellite type), 20 percent pyrite and 20 percent quartz.

Change in Volume of Clay Particles During Acidizing—At this point it is of intrest to compare the relative volume of the clay particles in the various environments which are brought about by acidizing of a formation. Clay particles found in place occupy a certain volume. If these same clay particles adsorb crystal, broken-bond or planar water from the acid solution, they will swell, increasing the volume. The conversion of the clay to a hydrogen clay will flocculate the particles, thus decreasing the volume. The net effect of this action will be that the volume of the hydrogen clay will be greater than the original volume of the clay in those cases in which the clays have adsorbed appreciable quantities of water. In the instance of those clays which have adsorbed no water or only small amounts upon contact with acid, the volume of the hydrogen clay will be smaller than the original volume of the clay.

As the hydrogen clays are converted to calcium or magnesium clays by neutralization of the acid, the volume of the clay particles at first will decrease slightly and then increase very materially in volume. The final volume of the calcium and magnesium clays at the conclusion of the acidizing treatment will be greater than the original volume of the clays in those cases in which the clays have adsorbed appreciable quantities of water, i.e., clay particles that originally were completely enclosed by limestone or dolomite crystals.

Those clays which have not adsorbed water, or only very little, during the acidizing may occupy a smaller, or about the same, volume after acidizing, depending upon the nature of the original clay. If the original was a sodium clay, then the clay obtained after acidizing will be considerably smaller in volume. If the original was a calcium clay, then the final clay will have about the same volume, or possibly slightly smaller. Thus, the clay particles deposited

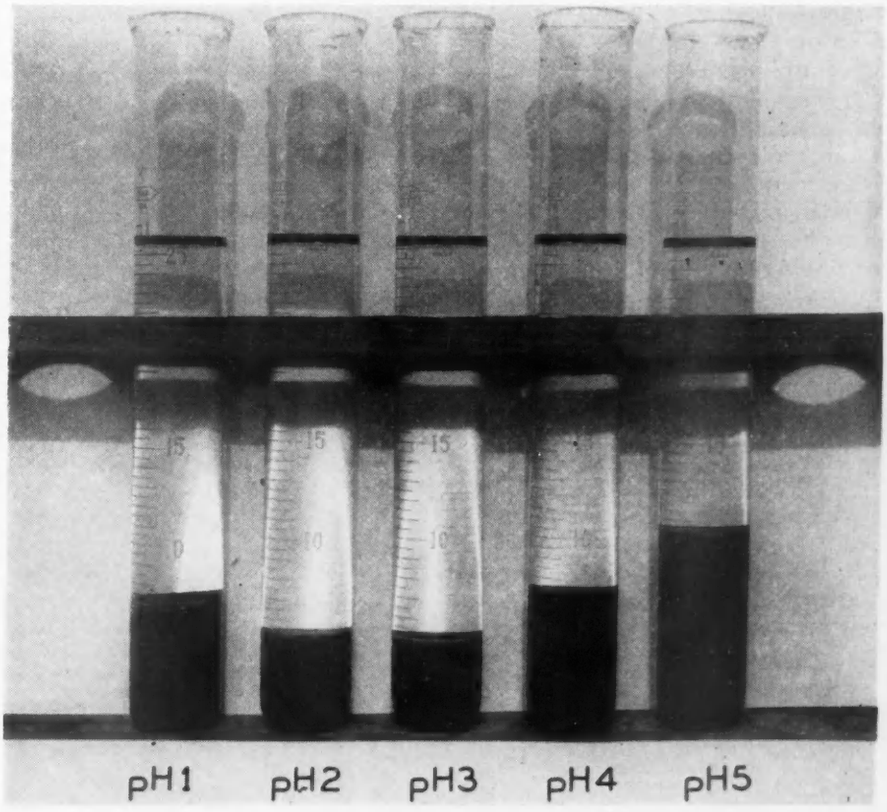


FIGURE 1

from drilling mud will decrease in volume as a result of acidizing. Those particles which originally were a part of the formation and which were in the flow channels in contact with interstitial water will change in volume very little during acidizing.

Silicate Swelling Control Agents

Since the clay minerals can cause reduction in the permeability of an acidized section it is advisable to minimize this effect as much as possible. One method of accomplishing this end is to use silicate swelling control agents in the acid solution. These materials will maintain the environment surrounding the clay particles in such a manner that the particles will be kept in a state of minimum swelling while being converted from a hydrogen to a calcium clay during the acidizing process. The value of an agent of this type is revealed by the data in Table 2.

The results given in this table were obtained by subjecting an excess of various formations to 15 percent hydrochloric acid solutions and then measuring the volume of the swollen clay minerals. Following this the tests were repeated with a silicate swelling control agent present in the acid solution. Care was taken to insure that the same amount of acid insoluble materials was present in each corresponding case. The data are reported as the percentage reduction in volume of the swollen clay minerals brought about by the use of the silicate swelling control agent.

The value of silicate swelling control agents in acidizing is three-fold: (1) in the reduction of emulsion or B.S. content of the produced oil, (2) in the increase in permeability of the formation, and (3) in the ease of spent acid return from the formation.

The reduction of emulsions is based upon the fact that clays are excellent emulsifying agents for oil in water systems. This type of emulsion is not the normal type experienced in breaking out crude oil-brine emulsions where the emulsion usually is of the water in oil type. Oil in water emulsions with clay emulsifying agents often are obtained following the acidizing of limestone and dolomite formations. Since the clay minerals in this instance exist as a film around the droplets of emulsified oil, the greater the surface area of the clays the greater will be the amount of emulsion formed. When ever the volume of the clays is decreased the surface area will be reduced, which will likewise decrease the amount of emulsion. It is for this reason that the amount of emulsion will be reduced when silicate swelling control agents are present in the acid solution.

Laboratory tests, as well as field experience, have shown that by decreasing the volume of the clay minerals 66 percent the amount of emulsion can be decreased by as much as 80 percent. The effect of this reduction in emulsion has brought about the situation where the wells following acid treatment have cleaned up to pipe line oil in two or three hours of swabbing, whereas the normal swabbing time has been 24 to 36 hours.

Another value of a silicate swelling control agent is the reduction in volume of the clay materials which in turn will increase the permeability of the formation. This has enabled acidizing to be used in certain fields in which conventional acid treatments have been unsuccessful. The increase in permeability of the formation allows for easier and more complete return of the spent acid to the well bore. The reduction of emulsion also helps materially in the return of the spent acid. The results of treatments using silicate swelling control agents are given in Table 3.

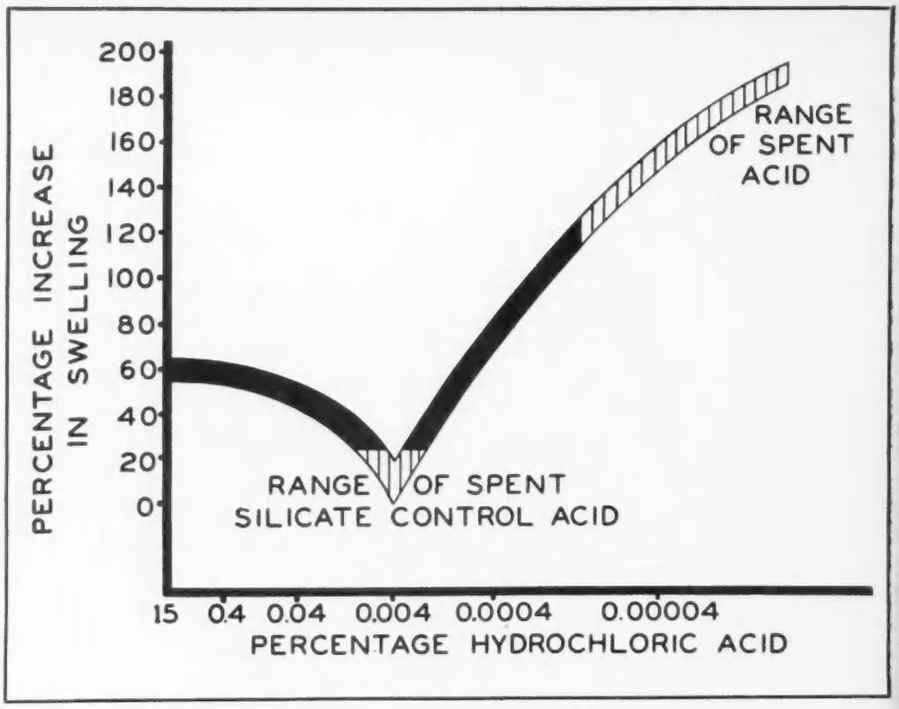


FIGURE 2. Swelling of clay minerals during acidizing.

Silicate Control Acid Treatments

The first well tabulated in Table 3 had been acidized in a manner conventional for its area with 900 gallons of acid, resulting in a potential of 240 barrels of oil per day. Following the test it became necessary to kill the well with mud in order to remove a formation packer. When the well was put back on production it made only 33 bopd. The reduction of oil was believed to be caused by clay materials from the drilling mud reducing the permeability of the formation. On the basis of this reasoning, the well was re-acidized with 10,000 gallons of silicate control acid. The result of this treatment was an increase, even over that obtained from the original acid treatment, to 340 bopd.

A treatment which illustrates the value of the silicate control agent for reducing base sediment content of the produced fluid is that of the second Upper Clear Fork well listed in the tabulation. An offset well, comparable in all respects, was acidized with

TABLE 2
Reduction of Swelling of Clays by Use of Silicate Control Agents

Formation	Pool and Location	Illite (Percent)	Bentonite (Percent)	Amorphous Silicates (Percent)	Felsdpar Type Minerals (Percent)	Quartz (Percent)	Anhydrite (Percent)	Percent Reduction from Use of Silicate Control Agent
.....	.....	..	100	..	..	..	..	57
.....	.....	100	..	..	..	..	..	69
Arbuckle.....	Workman, Kansas..	15	..	..	10	75	..	54
Ft. Riley-Upper...	Hugoton, Kansas...	40	..	..	10	35	15	48
Grayburg.....	C-Bar, Texas.....	50	..	..	..	35	15	70
Harrington.....	Hugoton, Kansas...	..	..	30	30	40	..	50
Winfield.....	Hugoton, Kansas...	..	..	40	..	60	..	79
San Andres.....	Levelland, Texas...	..	..	75	..	25	..	53

AXELSON *First Choice*

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER

AXELSON FIRST CHOICE FOR PETROLEUM PUMPING EQUIPMENT

You can argue quality at the surface but it's proved at the bottom of the well.

Axelson sucker rods and sucker rod couplings offer a combination which assures top performance under all pumping conditions.

. . . ASK AN AXELSON EXPERT

LSON MANUFACTURING CO. • PLANTS — Los Angeles 58; St. Louis 16 • OFFICES — York City 7; Tulsa 1; Buenos Aires, Argentina; Caracas, Venezuela • DISTRIBUTORS nes & Laughlin Supply Co.; Great Northern Tool & Supply Co.; Industrial Agencies, San Fernando, Trinidad, B.W.I.; Industrias Waldrip & Campbell, Barcelona and acaibo, Venezuela; Dominion Oil Field Supply Co., Ltd., Calgary, Canada; South rican Supply Co., Avenida Tacna 592, Lima, Peru.

2000 gallons of regular hydrochloric acid. The well in which the silicate control acid was used flowed back the oil flush and spent-acid water in three hours. The other well, for comparison, had to be swabbed three times following which it flowed back the flush oil and spent acid water in a period of four hours. Both wells then were tested for six hours.

The well which had been treated with the silicate control acid made an average of 4 percent water during the test. It did not produce any base sediment except during the fifth hour, at which time it made 4 percent. The offset well, in which the silicate control agent was not used, made base sediment all during the test, the amount varying from 14 to 22 percent, with an average being 17 percent. This well produced an average of 3 percent water. The well treated with silicate control acid produced an average 25.5 barrels of oil per hour, compared to an average of 23.5 barrels of oil per hour for the offset well.

An illustration of the ease if spent-acid water return together with reduction in base sediment content is that of the third Upper Clear Fork well shown in the table. This well is located in a different section of the Goldsmith 5600 pool from the wells previously considered. A comparable well to this also was treated with the same amount of acid, but without the silicate control agent. The well treated with the silicate control agent included in the acid flowed back the oil flush and spent-acid water in eight hours. The comparison well did not flow, requiring the oil flush and spent-acid water to be removed by swabbing, consuming a ten-hour period. Both wells then were tested for six hours.

The well in which the silicate control acid was used flowed during the test, making 2 percent base sediment during two of the six hours. Where the silicate control agent was not used, the well had to be swabbed once each hour. It made base sediment continuously, the amount varying from 1 to 6 percent with an average of 3 percent. The well which had been treated with the silicate control acid produced slightly more oil during the test, averaging 7.0 boph, as compared to 6.5 boph for the other well.

The Devonian well listed in the tabulation tested natural at 72 bopd. Amorphous silicates were known to be present in this formation. The well cleaned up in 1.5 hours following treatment, at which time the potential was started. It then flowed at the rate of 384 bopd, through a 20/64-inch choke.

An example of the use of silicate control acid to increase production in those areas where conventional acid has failed is that of the two Grayburg wells located in the North Iatan pool. Acid insoluble material present in the formation consisted of 40 percent quartz, 35 amorphous silicates and 25 percent anhydrite.

The San Andres well in the Howard-Glasscock pool was in an area in which acidizing comparable wells had never given a potential of more than 100 bopd. Again in this case amorphous silicates were present in the formation.

An example of a treatment in which a small amount of the silicate control acid overcame reduction in permeability following a large gallonage acid treatment is that of the San Andres well in the Levelland pool. This well previously had been acidized with 11,000 gallons of acid resulting in a potential of 432 to 480 bopd. The well declined rapidly after this treatment. It then was reasoned that production was being restricted by clay minerals plugging the formation. Following re-acidizing of the well with 1000 gallons of silicate control acid it made a potential of 528 bopd.

The wildcat San Andres well listed in the table was swabbed dry prior to acidizing. The spent-acid water, together with flocculated mud, returned very easily following the treatment. This formation contained amorphous silicates together with drilling mud which had been lost into the zone while coring.

The last well listed in Table 3, in the Seven Rivers formation, Pimera pool, was shot with 128 quarts of nitroglycerine after which it tested two bopd. This formation was known to contain large quantities of clay minerals. The well then was treated with 500 gallons of silicate control acid, resulting in production of seven bopd.

Conclusion

The results of the acid treatments in which the silicate swelling control agents have been employed indicate the following as compared to conventional acid: (1) a greater increase in production, (2) a smaller amount of emulsion, (3) a shorter period of time for the oil to become of pipe-line quality, and (4) an easier return of the spent acid from the formation.

TABLE 3
Results of Silicate Control Acid Treatments

FORMATION	POOL and LOCATION	Production (Bbl. Oil/Day)		Amount Acid Used (Gallons)
		Before	After (Potential)	
Clear Fork-Upper	Goldsmith 5600, Texas	33	340	10,000
Clear Fork-Upper	Goldsmith 5600, Texas	..	615	2,000
Clear Fork-Upper	Goldsmith 5600, Texas	..	168	2,000
Devonian	Dollarhide, Texas	72	384	1,000
Grayburg	Howard Phillips, Texas	8	125	2,000
Grayburg	North Iatan, Texas	Show	35	3,000
Grayburg	North Iatan, Texas	2	40	3,000
San Andres	Howard-Glasscock, Texas	65	300	2,000
San Andres	Levelland, Texas	..	528	1,000
San Andres	Wildcat, Texas	Show	205	1,000
Seven Rivers	Pimera, New Mexico	2	7	500

About the Author

DR. PAUL H. CARDWELL, chief chemist for Dowell Incorporated, Tulsa, was graduated from Central Michigan Teachers College in 1935 with an A.B. degree. He obtained his Ph.D. degree from the University of Michigan in 1941, in which year he joined Dowell Incorporated. Author of a number of technical articles, he is a member of the American Chemical Society, Electrochemical Society, American Society of Mechanical Engineers, American Institute of Mining & Metallurgical Engineers and the National Association of Corrosion Engineers. Membership in honorary societies includes Phi Beta Kappa, Phi Kappa Chi, Sigma Xi and Phi Lambda Upsilon.

REFERENCES

[1] Hughes, R. V., "Importance of Clay Studies in Water Flood Operations," *Producers Monthly*, 11 No. 4, 13 (1947).

[2] Hauser, E. A., and LeBeau, D. S., "Colloid Chemistry of Clay Minerals and Clay Films" (Edited Alexander), pp. 191-213, Vol. 6, New York, Reinhold Publishing Corp. (1946).

[3] Hendricks, S. B., Nelson, R. A., and Alexander, L. T., "Hydration Mechanism of the Clay Mineral Montmorillonite Saturated with Various Cations," J. Am. Chem. Soc.; 62, 1457 (1940).

[4] Hofmann, U., and Bike, W., "Intracrystalline Swelling and Base-Exchange Power Montmorillonite," Kolloid-Z. 77, 238 (1936).

[5] Marshall, C. E., "Layer Lattices and Base-Exchange Clays," Z. Kirst., 91, 433 (1935).

[6] Grim, R. E., "Relation of Clay Mineralogy to Origin and Recovery of Petroleum," Bull. A.A.P.G., 31, 1491 (1947).

NATIONAL "TANK TOPICS"

National has concentrated its manufacturing "know-how" and facilities on the production of equipment that will save and conserve the most for the user. This standard of service, made possible through capable engineers, an intensive research program and modern plant facilities, keeps National on TOP!

It's a National

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

Quantitative Log Interpretation Of the San Andres Dolomite

By C. B. SCOTTY
The Texas Company, Houston

DATA ARE PRESENTED which indicate that a good quantitative estimate of the fluid content of a reservoir may be obtained from a combination of radioactivity and electric logs. Porosity is derived from the neutron log, and the interstitial water content is calculated from electric logs. It is shown that the empirical relations developed through correlation of core analysis and the logs from one well are applicable to another well producing from the same geological formation.

TWO wells, each in a different field in West Texas, which penetrate the San Andres dolomite were selected to show that there existed empirical relationships between electric and radioactive log data and laboratory data on core analysis of these wells. It was felt that such a selection of wells would yield a maximum amount of information with regard to the validity of quantitative log interpretation within a given well and in addition indicate the reliability of log interpretation based on empirical relationships when applied to other wells producing from the same geological formation but in different geographical locations. The San Andres dolomite in these fields exhibits very little visible porosity and permeability; therefore, a visual inspection of cores and cuttings is of doubtful value in selecting the sections to be tested for possible oil production. The log interpretation study for these wells was initiated in an attempt to establish a more satisfactory method for evaluating dolomite pay sections.

Experimental Procedure

A special drilling and coring program was established in drilling the wells in order to obtain a maximum amount of quantitative data for correlation with electrical and radioactivity log information. Both wells were drilled to the top of the prospective producing interval with conventional water base mud and 5½-inch casing was set. The water base mud was displaced with weathered crude oil, and the producing section was cored with a 4.7-inch bit. Oil was used as the circulating fluid during coring to facilitate a quantitative fluid content determination from the core samples.

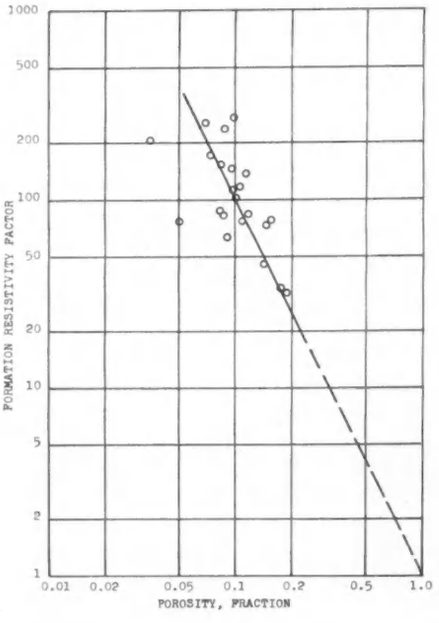


FIGURE 1. Well A, formation resistivity factor vs. porosity.

In the first well, designated as Well A, 96 percent core recovery was obtained. The drilling oil was then displaced with fresh oil and a spinner survey was made. Next, the oil was displaced with water and a number of electrical and radioactivity logs were run.

A 95 percent core recovery was obtained on the second test well, designated as Well B. After coring of Well B, the oil used for drilling was displaced with water and the electrical and radioactivity logs were run.

Core Analysis: The entire core samples were analyzed for water saturation, porosity, and permeability. Water saturation was obtained by extraction distillation using toluene; porosity was obtained by the saturation technique; and permeability was run in a horizontal direction using air.

Resistivity measurements at 100 percent water saturation were made by the laboratory on plugs cut from the large cores of Well A. These measurements were made using a synthetic brine of sodium chloride saturated with calcium carbonate and calcium sulfate, thus preventing decomposition of the core samples. Twenty-nine ¾ x 1-inch plugs were cut from the large cores which had been previously cleaned of all original fluid. The plugs were saturated with the synthetic brine and the resistivity measured by means of a four-electrode system using alternating current. Porosity was obtained on each sample, being determined by difference in weight, dry and 100 percent saturated.

Table 1 is a tabulation of porosity as determined on the large cores and the small plugs, and the "formation resistivity factor" which is defined by Archie[1] as the ratio of the resistivity

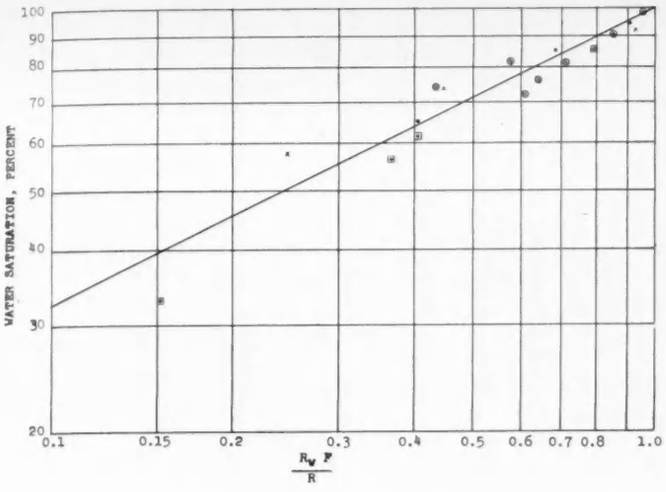


FIGURE 2. Well A, resistivity ratio at various water saturations.

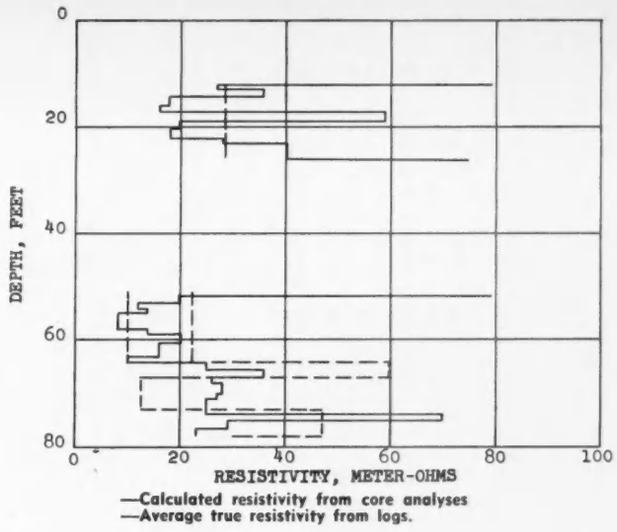


FIGURE 3. Well A, comparison of calculated and log resistivity.

of a core sample 100 percent saturated with water to the resistivity of the water. The average porosity as determined by the two measurements is in close agreement with the exception of the samples showing less than 2 percent porosity as measured on the large cores.

In addition to resistivity measurements at 100 percent water saturation, measurements of resistivity at various water saturations were made on five of the plug samples. The water saturation of the cores was reduced by means of capillary pressure apparatus using an air-water system. Resistivity was again measured by means of a four-electrode system using alternating current. The water saturation was determined gravimetrically.

Log Interpretation of Well A

Fluid Content: Calculations of the fluid content of a formation may be made by use of the resistance curves of the electric log, the known resistance of the formation water and the "formation resistivity factor." Corrections for the effect of hole size, invasion of mud filtrate, and electrode spacing in the recording of resistivity (resistivity read from the electric log) may be necessary to obtain the "true resistivity." The equations used in these calculations were empirically derived through experimental correlation, and the following is a brief discussion of the work from which the equations were obtained.

Because solid particles of the producing formation (sandstone, limestone, etc.) are practically nonconductors, the conductivity of the formations is due almost entirely to the water they contain. When the pore space is completely filled with water, the resistivity, r_w, of the formation is proportional to the resistivity R_w of the water in the pore space and it can be expressed by

$$r_w = F R_w \qquad (1)$$

where the constant of proportionality F is the "formation resistivity factor."

The resistivity factor embodies the effect of pore size distribution, and the degree of cementation; therefore, porosity of the formation affects the formation resistivity factor. Any change in the geometry of the pore space which increases the porosity usually decreases the resistivity factor. Archie[1] investigated the variation of F for a large number of sands and sandstones of the Gulf Coast area ranging from 10 to 40 percent in porosity. A plot on double logarithmic paper of the formation resistivity factor, F, vs. porosity, f, shows the following simple relationship:

$$F = f^{-m} \qquad (2)$$

where m is the slope of the line. Equation 2 gives a value $F = 1$ for $f = 1$, irrespective of the value of m. This is to be expected since under these conditions there is no solid matrix. The exponent m has been found to vary from 1.3 for unconsolidated sands to 2.0 for cemented formations.

Several investigators[1, 2, 3, 4, 5] have established the relationship between the oil or gas saturation of an unconsolidated sand and its resistivity. Even though some of the investigations were carried out using gas and some using oil, the results gave consistently:

$$S = \left(\frac{r_w}{R}\right)^x \qquad (3)$$

where S is the water saturation fraction, r_w is the resistivity of the sand with the pore space completely filled with water ($S = 1$) of resistivity R_w, and R represents the resistivity of the sand partially filled with oil or gas, the remaining pore space filled with water of resistivity R_w. The exponent x of Equation 3 was found to be 0.5 by all of the above mentioned investigators who used unconsolidated sand exclusively. Subsequent measurements on core samples showed that the exponent may vary considerably from formation to formation and even for different sections of a given formation. Values ranging from 0.49 to 0.9 have been observed.

An equation for calculating inter-

TABLE 1
Well A

DEPTH	Porosity Large Cores (Percent)	Porosity Plugs (Percent)	Formation Factors
41.1—42.2	1.75	0.06	235
41.1—42.2	1.75	0.74	745
43.8—45.0	2.08	0.08	110
48.7—49.5	1.61	0.49	230
51.1—52.7	1.70	0.05	88
Average	1.78	0.28	....
52.7—53.8	4.9	1.4	144
55.9—56.2	12.3	11.8	84*
56.2—57.5	11.8	14.1	46
57.5—58.8	9.3	3.5	207
58.8—60.1	7.2	6.9	251
60.1—61.4	8.5	5.0	77
60.1—61.4	8.5	11.3	138
61.4—62.8	10.2	10.9	76
62.8—64.0	9.4	8.7	82
64.0—64.9	12.3	14.8	73
64.9—66.5	10.8	17.4	34
66.5—68.0	6.9	0.8	149
68.0—69.2	7.9	9.8	275*
68.0—69.2	7.9	9.5	146
69.2—71.2	11.8	8.6	238
71.2—72.2	13.7	15.6	78*
72.2—73.4	13.4	8.4	152
73.4—74.5	13.5	9.8	112*
74.5—75.5	7.8	9.0	63
75.5—77.0	8.4	10.6	119
75.5—77.0	8.4	7.3	171
77.0—78.0	12.6	18.6	32*
78.0—79.5	8.1	8.1	88
79.5—81.0	10.6	10.0	101
Average	9.84	9.66	....

* Resistivity versus water saturation data has been obtained.

stitial water content from the electric log can be obtained by combining equations (1), (2), and (3). This empirical formula is:

$$S = \left(\frac{R_w \times F}{R}\right)^x \qquad (4)$$

with F = Formation resistivity factor—dimensionless

$F = f^{-m}$

S = Interstitial water saturation—fraction of porosity

R_w = Resistivity of formation water—meter-ohms

R = True resistivity of formation (derived from electric log) meter-ohms

f = Porosity—fraction

x = Exponent of Equation 4—dimensionless

m = Exponent of Equation 2—dimensionless

It is therefore possible to calculate the water saturation from a resistivity log (R) having obtained the values of f, m, and x from other information. The porosity, f, can be determined from core analysis or it can be expected to be derived from neutron-gamma logs.[9] The exponents m and x can be determined by core analysis for the particular well or formation in question.

Validity of the above relationships was determined by core analysis from Well A. A plot of formation resistivity factor versus porosity is shown in Figure 1. Data are scattered to such an extent that one might hesitate to show a porosity-formation resistivity factor relationship. In addition to the error of measurement, the scatter of data is undoubtedly due partially to the variation in the lithology of the formation. The factors governing the relationship of porosity to formation resistivity factor are complex, and in a formation with low porosity and permeability a simple mathematical relationship (Equation 2) can only be considered a practical approximation. The line drawn to represent this relationship in Figure 1 is based on the data for the core samples having a porosity greater than 3 percent.

Figure 2 is a plot of the resistivity measurements at various water saturations in accordance with Equation 4. The slope of the average line is the exponent x and it has a value of 0.49.

From these resistivity measurements, a resistivity curve for the formation based only on core analysis data was calculated. This was done by means of Equations 1 and 2 using $m = 2$, $x = 0.49$, $R_w = 0.032$ meter-ohms, and porosity values as obtained on the large cores. The values of water saturation, S, used in the above calculation were the values obtained by large core analysis. Such values are representative of the formation due to the tightness of the formation and the fact that the cores were cut in oil. This resistivity curve is shown in Figure 3, the calculations being made only for the zones showing greater than 4 percent average porosity. These calculations are thus made on the assumption that the average relationships developed from the experimental data are representative of the formation. If the computed log agrees closely with the electric log it may be assumed that in other wells the fluid saturation can be calculated from porosity and electric logs only.

Resistivity Curves: Three resistivity curves obtained on Well A are shown in Figure 4. Since the formation is heterogeneous with respect to resistivity, it was necessary to divide the logged interval into a number of zones of relatively uniform resistivity in order to derive values of "true" resistivity. The boundaries of the various intervals as indicated by the three curves are in good general agreement with the exception of the bottom 15 feet, the zone shown as most permeable by the spinner survey and by core analysis. It should be pointed out that oil was injected into the formation during the spinner survey before the electric logs were run.

The apparent resistivity as indicated by the three curves is shown in Table 2. For the uniform sections, the minimum value for conductive beds and the maximum value for resistant beds was used. The apparent resistivity of the more heterogeneous beds was obtained by visual averaging of the resistance over the section. The "true" or corrected resistivity as recorded in Table 2 was obtained by

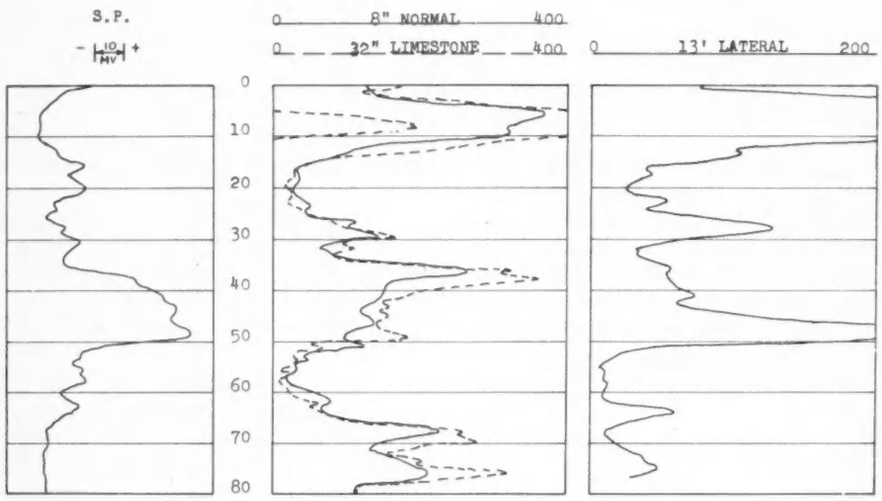


FIGURE 4. Well A, composite of logs.

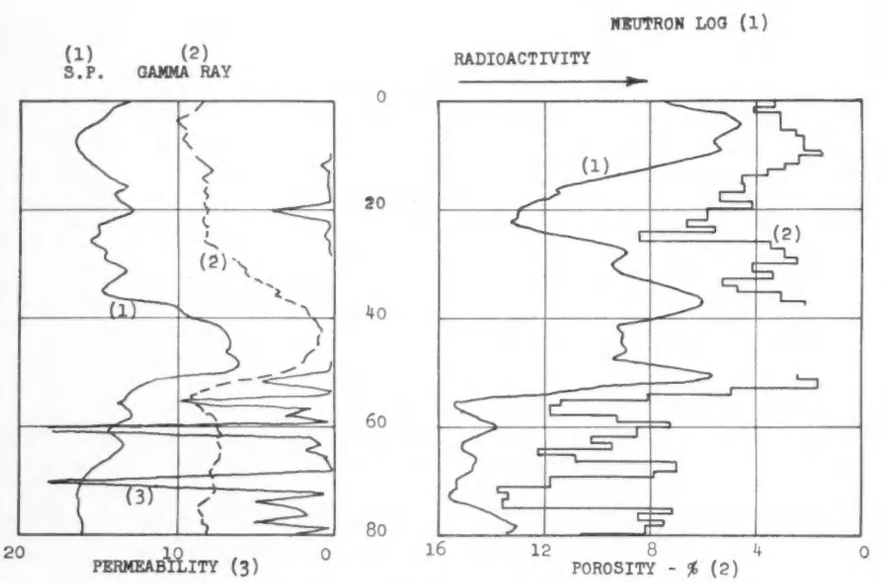
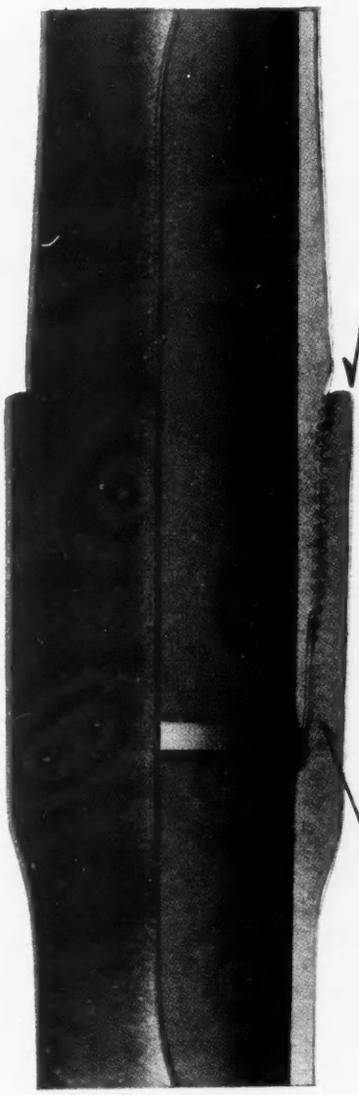


FIGURE 5. Well A, comparison of logs and core graphs.

SPANGSEAL TUBING

features include . . .



INTEGRAL JOINT

Only two threaded elements. Use of couplings, requiring four threaded joints is eliminated. Female joint ends are treated chemically to provide anti-galling surface.

ECONOMICAL

SPANGSEAL Tubing saves you money. Costly repair jobs and remedial work due to leakage are eliminated.

ADDITIONAL CLEARANCE

Extra clearance is obtained because the maximum OD of the SPANGSEAL Joint is smaller than the maximum OD of a coupling.

STREAMLINED EXTERIOR

The streamlined exterior contour of the female end reduces the chance of hanging up while running.

LEAK RESISTANT

Made up properly, threads serve only as a mechanical interlock. Conical sealing surfaces form a complete-circumferential seal.

For complete dependability, specify SPANGSEAL Tubing for your wells.

THE NATIONAL SUPPLY COMPANY

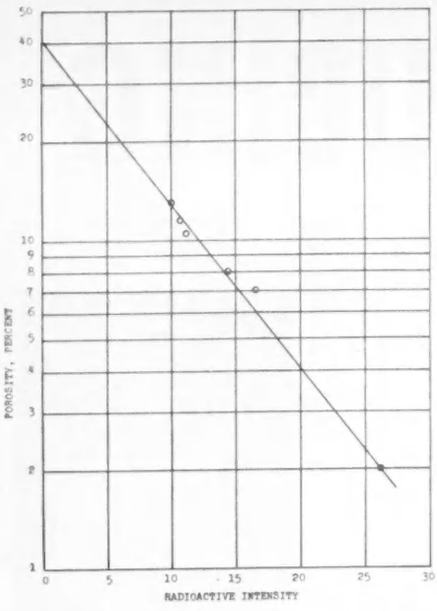
Spang-Chalfant Division—General Sales Offices: **Pittsburgh, Pa.**

Division Tubular Offices:

DENVER, COLORADO • FORT WORTH, TEXAS • LOS ANGELES, CALIFORNIA • PITTSBURGH, PENNSYLVANIA • TULSA, OKLAHOMA • CALGARY, ALBERTA, CANADA

SUPERIOR AND ATLAS ENGINES

NATIONAL BLUE PRODUCTS



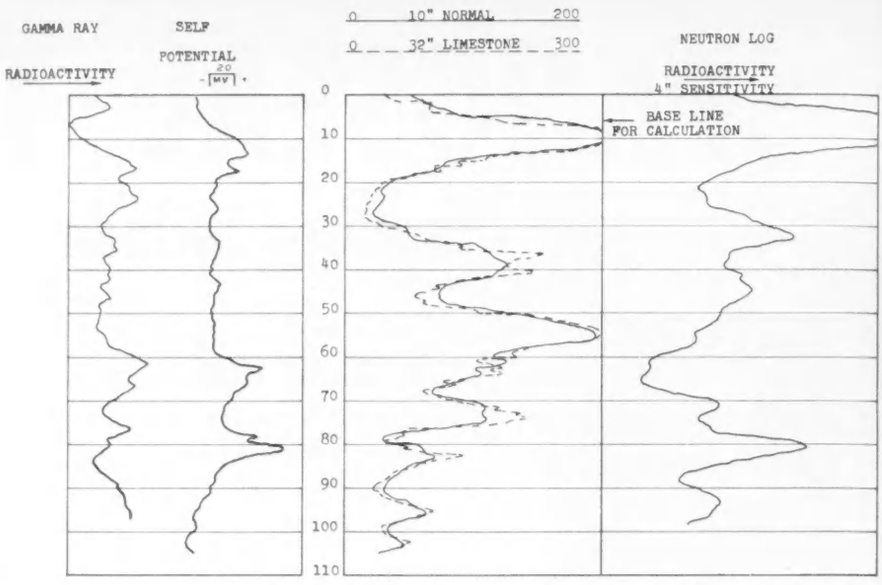


FIGURE 6 (left). Well A, porosity vs. neutron log radioactive intensity.
FIGURE 7 (right). Well B, composite of logs.

correcting the apparent resistivity by use of the Guyod[6] bed thickness corrections and the Schlumberger[7] departure curves (no invasion) for the correction due to the mud column. The departure curves are calculated on the basis of point electrodes in the hole. Since the bore hole diameter is quite small, 4.7 inches, the equivalent diameter of the annular space was used. The departure curve for the lateral device was used for the "limestone sonde" curve.

Table 2 shows that the corrected or "true" resistivity as calculated for the two short spacing curves (10-inch normal and 32-inch limestone sonde) are in better agreement than the apparent resistivity. The one exception is for the zone 26 to 30 feet. This discrepancy is probably due to the characteristic response of a lateral type curve for resistant beds of thickness between one and one-half times the electrode spacing. The corrected or true resistivity for the 13-foot lateral curve does not differ from the apparent resistivity with the exception of the three high resistance sections.

It is noted from Table 2 that the two short spacing curves give values of resistivity which are comparable; however, there is a marked discrepancy between these values and the ones obtained from the 13-foot lateral curve. There are a number of possible explanations for these discrepancies. The lower values recorded by the 13-foot lateral in the zones 30 to 46 feet and 51 to 64 feet are probably due in part to the screening or shadow effect of the thin, more resistant beds immediately above them. The values of resistance for the beds at 4 to 12 feet and 46 to 51 feet when corrected for bed thickness and bore hole resistivity show the largest variation between the short and long spacing curves. This difference may be due to inability to correct the curves properly or to a marked change in lithology of the formation investigated by the different spacing curves. These zones are of relatively little importance as they have very low porosity, and therefore only a small change in porosity can account for a large change in resistivity.

The two zones from 12 to 26 feet and from 51 feet to total depth are of the greatest interest as these are the zones with sufficient porosity to be considered productive. A variation in resistivity from 23 to 34 meter-ohms is obtained from the three curves for the interval 12 to 26 feet. The average of 28.5 meter-ohms is plotted on Figure 3 for comparison with the resistivity calculated from core analysis. This range of resistivity results in a calculated water saturation from 71 to 77 percent of the pore space compared to an average of 72 percent by core analysis.

The zone from 51 feet to total depth has been divided into four intervals for log interpretation. This entire interval is permeable as indicated by core analysis and the spinner survey. For the interval 51 to 64 feet the corrected resistivity as recorded by the short spacing curves are in close agreement, 20 and 24 meter-ohms. The resistivity from the 13-foot lateral curve is 10 meter-ohms; a value which is anticipated to be low due to the "shadow effect." Figure 3 shows that the average value of 22 meter-ohms as deter-

TABLE 2
Well A

Depth	8″ Normal		32″ Limestone		13′ Lateral	
	App. R.	Corr. R.	App. R.	Corr. R.	App. R.	Corr. R.
0— 4	130	125	160	110	75	75
4—12	365	325	590	450	250	1300
12—26	30	27	25	23	34	34
26—30	120	186	125	85	126	200
30—35	70	65	100	70	33	33
35—38	260	270	360	250	57	57
38—46	130	125	160	110	74	74
46—51	110	100	180	120	215	1000
51—64	27	24	22	20	10	10
64—67	...	...	...	...	60	60
67—73	...	...	...	...	12.5	12.5
73—78	...	...	...	...	47	47

$$\frac{AM}{d} = \frac{8}{\sqrt{4.7^2-1^2}} = 1.7 \qquad \frac{AO}{d} = \frac{32}{\sqrt{4.7^2-1^2}} = 7$$

$$\frac{AO}{d} = \frac{13 \times 12}{\sqrt{4.7^2-3.7^2}} = 52 \qquad Rm = 5 \text{ meter-ohms}$$

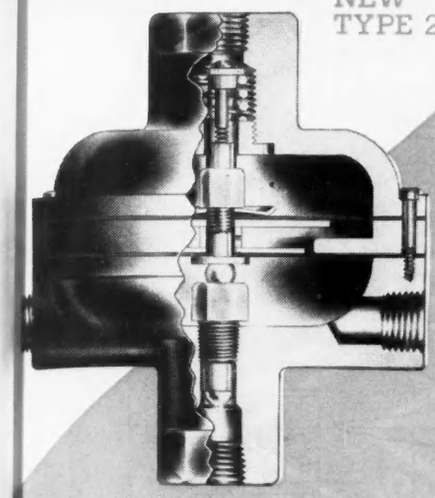
TABLE 3
Well B

Depth Interval	10″ Normal		32″ Limestone	
	Apparent Resistivity	Corrected Resistivity	Apparent Resistivity	Corrected Resistivity
19— 31	27	21	30	21
31— 36	80	66	105	61
36— 41	125	115	200	110
41— 50	75	64	100	60
50— 58	180	195	285	220
58— 64	115	102	175	104
64— 71	75	64	120	66
71— 76	108	105	196	110
76— 81	35	27	50	30
81— 84	69	66	135	77
84— 87	69-30	66-22	135-35	77-23
87— 92	30	22	35	23
92— 96	60	53	90	54
96—101	32	24	42	26
101—104	47	47	75	43

$$\frac{AM}{d} = \frac{10}{\sqrt{4.7^2-3.7^2}} = 3.3 \qquad \frac{AO}{d} = \frac{32}{\sqrt{4.7^2-3.7^2}} = 10.7$$

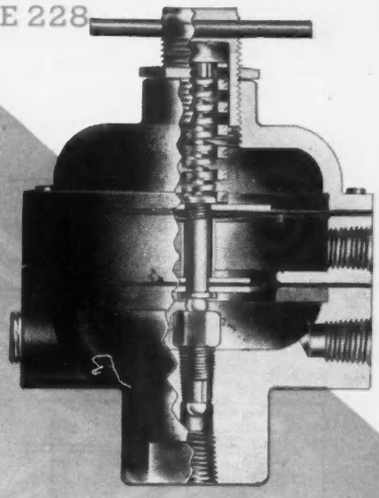
$R_{Mud} = 1.1$

NEW
TYPE 227



A delayed action, fixed ratio relay. For use with series-operating diaphragm control valves in "split ranges". Permits full valve travel with primary control pressure changes as low as 2 or 3 pounds.

NEW
TYPE 228



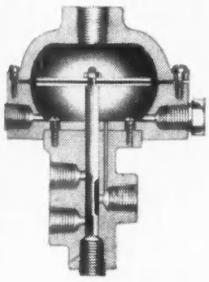
Reverse action relay delivers maximum pressure output at minimum input or vice versa. No modification in either pilot or valve hook-up necessary. Or install in bypass to achieve reversal of valve closure in relation to pilot action if required occasionally.

Get greater speed of action ...Install BS&B "Climax" Relays

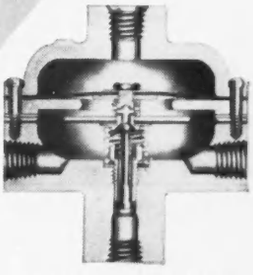
• BS&B "Climax" Relays serve as primary regulator valves to step up the action through the control of supply medium to the control valve.

The wide BS&B "Climax" line provides a variety of functions ... one-to-one, fixed ratio, variable ratio, delayed or reverse action. They may be used to load diaphragms or pistons with liquid operating medium while the control instrument loads the relay with gas. Booster action is also possible, to enable small capacity controls to handle larger duties.

Write today for the latest illustrated catalog Section 109, complete with descriptions, performance figures, installation data.



TYPE 209
1 to 1 Ratio

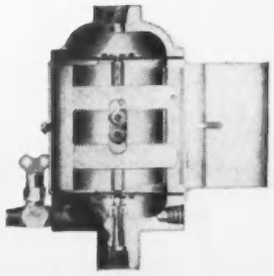


TYPE 217-4A
Fixed Ratio

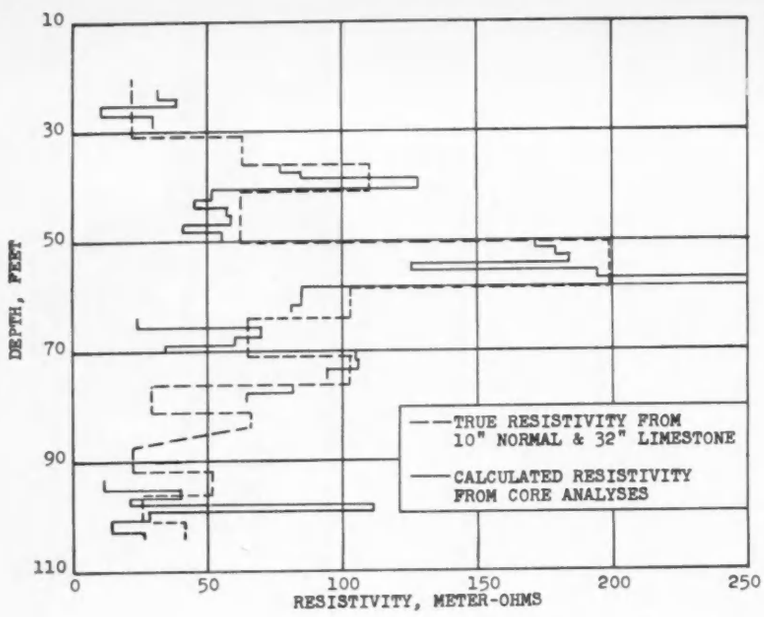
BLACK, SIVALLS & BRYSON, INC.
Climax Controls Division
Adv. Dept. Room 53B 7502 East 12th St. Kansas City 3, Mo.

BS&B

"Climax"
RELAY REGULATORS



TYPE 224
Variable Ratio



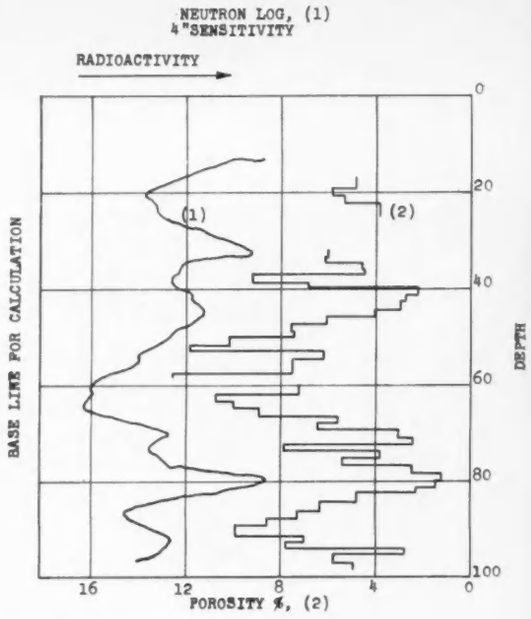


FIGURE 8 (left). Well B, comparison of calculated and log resistivity.
FIGURE 9 (right). Well B, comparison of neutron log with core analysis porosity.

mined from the short spacing curves is somewhat high, probably due to partial displacement of formation water by the oil injected during the spinner survey. The value of 10 meter-ohms from the 13-foot lateral is less than the calculated resistivity as anticipated.

The remaining porous interval from 64 to 78 feet is indicated as highly resistive by the short spacing curves. These values of resistivity are appreciably above the resistivity recorded by the long lateral; the difference being attributed to displacement of formation water by oil as this zone was indicated as having the highest permeability by the spinner survey. The resistivity obtained from the long spacing curve is plotted in Figure 3 for comparison with the calculated resistivity. The calculated curve does not show the marked change in resistivity indicated by the log; however the average values are in general agreement.

This well was a poor producer. Porosity and permeability are quite low and the water saturation is relatively high. Even though the empirical relationships developed from core analysis are not very exacting and the formation is extremely heterogeneous, the calculation of fluid content from the resistivity curves is in good average agreement with core analysis. The results from this well were sufficiently encouraging that a second well was evaluated in a similar manner.

Self-Potential and Gamma-ray Curves: At one time it was thought that the self-potential curve may be used as a direct indication of permeability. Figure 5 shows a plot of permeability superimposed on the self-potential curve. It is evident from this figure that the self-potential curve cannot be used as a direct indication of permeability which is normally considered sufficient for production.

From Figure 5 it may be seen that the self-potential and gamma-ray curves are quite similar. It is noted however that the gamma-ray curve indicates "shale" by increased radioactivity nine or ten feet above the break on the self-potential curve. The self-potential curve is in better agreement with the core description and the response of the neutron curve than the gamma-ray curve, therefore it may be concluded that there is some type of radioactive material in part of the dolomite section contributing to the gamma-ray curve.

TABLE 4
Well B

Depth Interval	Feet Pay Core Analysis	Average Porosity Core Analysis	Average Water Saturation		Barrels Oil in Place per Acre	
			Core Analysis	Logs	Core Analysis	Logs
19— 31	8.9	4.6	74	86	830	450
31— 36	0	Low	..	..	....	....
36— 41	4.7	5.4	34	32	1300	1340
41— 50	9.0	4.6	57	53	1390	1510
50— 58	8.4	8.3	17	16	4500	4550
58— 64	4.7	8.9	23	20	2500	2600
64— 71	7.8	8.3	32	28	3420	3620
71— 76	4.2	4.0	43	45	740	720
76— 81	3.1	5.8	46	58	750	590
81— 84	0	Low	..	..	....	....
84— 87	0	Low	..	..	....	....
87— 92	4.9	6.6	..	63	930*	930
92— 96	4.9	8.7	50	30	1660	2320
					18020	18630
96—101	4.2	5.4	58	67	740	580
101—104	3.7	4.5	94	68	80	410

Formation Resistivity Factor, $F = (\text{porosity})^{-2.0}$

$$\text{Percent Water Saturation} = 100 \left\{ \frac{0.032\ F.}{\text{true resistance}} \right\}^{0.49}$$

* Assumed the same as log value as no core analysis was available.

Figure 5 is a plot of the neutron curve and a reverse plot of porosity. With the exception of the shaly section, 37-50 feet, it will be noted that the neutron curve follows remarkably close to the plotted porosities.

Neutron Curve: In order to determine porosity from the neutron curve, it was necessary to establish a base or reference line on the radioactivity scale. Since no reference line is given on the log, the low intensity opposite shales was chosen as the base line and was thus designated as zero. This base line was chosen due to the apparent consistency of the values opposite predominant shale streaks as evidenced in the cased section of this well.

Figure 6 is a plot of porosity vs.

The sign of *Good Supplies!*

You see signs of SUPERIOR all over the mid-continent oil area. Wherever there is oil, gas and industrial activity you'll find a convenient SUPERIOR store, with a complete line of national-known brands you can depend on to do the job. When you need "on-the-spot" service and supplies—or technical advice—call your nearest SUPERIOR store or office.

SHREVEPORT, LA.
BATON ROUGE, LA.
LAFAYETTE, LA.
TINSLEY, MISS.
STEPHENS, ARK.
CAMDEN, ARK.
EL DORADO, ARK.
CARTHAGE, TEXAS
DALLAS, TEXAS
ABILENE, TEXAS
HOUSTON, TEXAS
TULSA, OKLA.

SUPERIOR'S machine shop and fabrication plant in Shreveport, La., is proving on piping jobs of oil, gas, chemical and power industries the efficiency and profits in the "Superior method" of prefabrication. Write for SUPERIOR'S booklet, "Save Time and Money," See how the "Superior method" can mean profits to YOU!

SUPERIOR IRON WORKS & SUPPLY COMPANY, INC.

1202-04 MARSHALL STREET • P. O. BOX 1800 • SHREVEPORT, LA.

NEW YORK CITY — TELEPHONE OREGON 9-3650

radioactivity. This correlation is for a neutron log of 4.8 inches sensitivity and 1-inch deflection from the base line is arbitrarily called ten radioactive units. Sensitivity of 4.8 inches represents maximum deflection on the log for a reference source. A change in sensitivity on the log requires only a linear change in the radioactive scale of Figure 6. The semilogarithmic plot shows a linear relationship between porosity and radioactivity.[8] There are several variables such as the presence or absence of casing and changes in bore hole size which affect this correlation.

Well B

Logs obtained on Well B are shown in Figure 7. The quantitative interpretation of the logs on this well is based on the empirical relationships established by core analysis on Well A.

Resistivity Curves: Only two short spacing resistivity curves were run on this well: 10-inch normal and 32-inch limestone. As in the case of Well A the logged interval was divided into zones of relatively uniform resistivity. The apparent resistivity was corrected for the effect of bed thickness and the mud column as described for Well A. The apparent and "true" or corrected resistivity thus obtained are shown in Table 3. It may be seen from this table that the "true" resistivity obtained for the two curves are in excellent agreement whereas the apparent resistivities show a marked discrepancy. Figure 8 is a plot of the average of the "true" resistivity obtained from the 10-inch normal and 32-inch limestone curves. Superimposed on these values is the calculated "true" resistivity obtained from Equation 4 using core analysis values of porosity and water saturation. The exponents used in Equation 4 were those developed by core analysis for Well A. By a reverse of the above calculation, using the average true resistivity obtained from the logs and porosity from core analysis, the values of oil and water saturation recorded in Table 4 are obtained. The results are in exceptionally close agreement with core analysis; the over-all error is less than 3 percent.

Fluid Content from Combination of Logs: In order to obtain an estimate of oil in place from logs alone, a composite of the logs, Figure 7, was prepared using the casing seat as the reference point. The neutron log was used to obtain porosity, using the correlation obtained from Well A. (Figure 6 corrected for sensitivity.) Figure 9, a plot of the neutron log and a reverse plot of core analysis porosity, demonstrates the similarity of the two curves. It is noted from Figure 7 that the self-potential curve and the gamma-ray curve are not in exact agreement, therefore, based on the experience of Well A, the self-potential curve was used as the basis of establishing the extent of the shaly sections.

Having established the porosity of the formation from the neutron and self-potential curves, fluid calculation may be made from Equations 2 and 4 using the values of m and x determined on Well A, and the corrected resistivity obtained from the resistivity curves. Table 5 gives the results of this study. Comparing Tables 4 and 5, it may be seen that a total of approximately 18,000 barrels of oil in place per acre are obtained from core analysis, 18,600 barrels from core analysis porosity and resistivity logs, and 19,600 barrels from the logs independent of core analysis. A comparison of core analysis porosity and neutron derived porosity as tabulated in Tables 4 and 5 does not show as good a correlation as Figure 9. This can be accounted for by the fact that in Figure 9 the data were shifted to show the best correlation, whereas for the log interpretation the logs were aligned without the aid of core analysis as would be necessary if no core analysis were available. Due to this procedure the data as presented does not show as good a check as would be obtained by a close correlation with core analysis; however it is felt that this procedure is a better representation of quantitative log interpretation when no core analysis data are available.

About the Author

C. B. SCOTTY was graduated from Rice Institute in 1944 with a B.S. degree in Chemical Engineering. Since graduation he has been with The Texas Company as a petroleum engineer in production research. For the last four years he has been actively engaged in well log interpretation.

TABLE 5
Well B

Depth Interval	Feet Pay From Log	Average Porosity Neutron Log	Average Water Saturation Log	Barrels Oil in Place, Per Acre
19—31	8	5.8	67	1200
31—36	0	Low	..	....
36—41	5	5.2	33	1350
41—50	9	4.2	56	1290
50—58	8	7.8	17	4040
58—64	3	15.3	12	3130
64—71	5	11.2	21	3440
71—76	5	7.2	48	1460
76—81	0	Low	..	....
81—84	0	Low	..	....
84—87	3	8.6	34	1320
87—92	5	8.4	46	1760
92—96	4	4.6	55	640
				19630

End of Neutron Log

Conclusions

Based upon log interpretation from the two wells in the San Andres dolomite, the following conclusions and generalizations may be drawn:

1. The apparent resistivity from resistivity logs of various spacing and electrode arrangements are not in close agreement. Application of published methods of deriving "true" or corrected resistivity appreciably improves the correlation between the various resistivity curves. The true resistivity thus obtained is in better agreement with core analysis than the apparent resistivity.

2. The self-potential curve is a better indication of shaly zones than the gamma-ray curve. This is probably due to the presence of radioactive material in some sections of the dolomite.

3. A good quantitative estimate of porosity may be derived from the neutron log.

4. Even though the laboratory measurements of resistivity indicate poor correlation with the empirical equations used to calculate fluid content from the resistivity curves, the use of the average relationships developed results in estimates of fluid content which are in close agreement with core analysis.

5. If there is any marked degree of invasion, long spacing resistivity curves are required to determine a good estimate of the noninvaded formation resistivity.

ACKNOWLEDGMENT

The author wishes to express his appreciation to the management of The Texas Company for granting permission to publish this paper.

REFERENCES

[1] G. E. Archie, Trans. AIME **146**, 54 (1942).
[2] R. D. Wyckoff and R. H. Botset, Physics 7, No. 9, September, 1936.
[3] J. J. Jakosky and R. H. Hopper, Geophysics 2, No. 1, January, 1937.
[4] M. Martin, G. H. Murry, and W. J. Gillingham, Geophysics 3, No. 3, July, 1938.
[5] M. C. Leverett, Trans. AIME **132**, 149 (1939).
[6] H. Guyod, Series in *The Oil Weekly* (1944-45).
[7] Schlumberger Well Surveying Corporation, Resistivity Departure Curves, Schlumberger Document No. 1, September, 1947.
[8] R. E. Bush and E. S. Mardock, Journal of Petroleum Technology **2**, No. 1, 19 (1950).

LANE-WELLS PACKER INVENTORY PLAN

56 Locations to give you the right packer for your job . . . right when you need it!

There's a Lane-Wells Packer that's just right for your job — right in type, right in size, right in construction — and Lane-Wells sees to it that that packer is ready for you when you need it. 56 Lane-Wells branches stock all the most-called-for packers in all the regular sizes, putting the packer you want almost within arm's reach. Saves plenty of waiting, saves trouble, saves money for you — this Lane-Wells Packer Inventory Plan.

AP-4C

IT'S PART OF

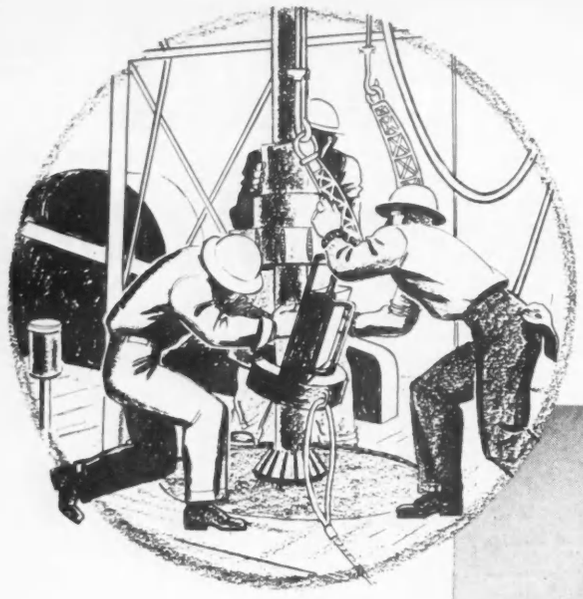
Tomorrow's Tools — Today!

. . . by . . .

General Offices, Export Office and Plant • 5610 So. Soto St. Los Angeles 58, California

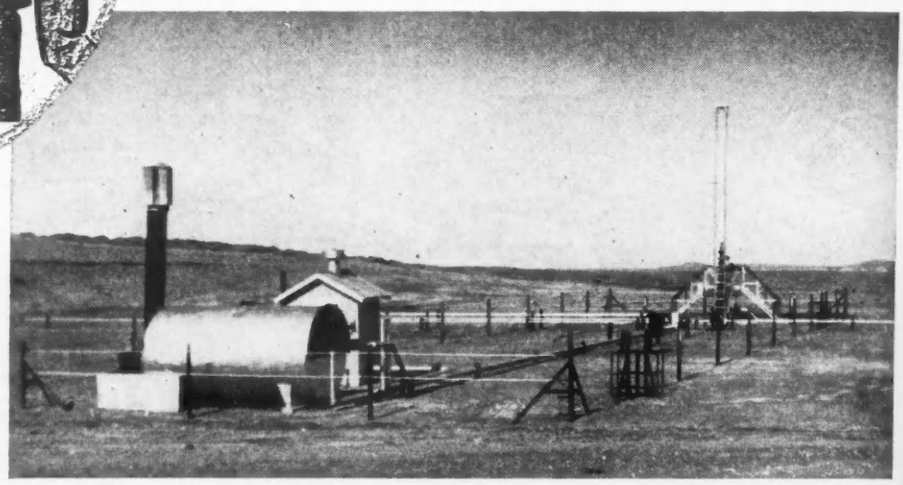
LANE TECHNICAL Oil Field Services WELLS

Los Angeles • Houston • Oklahoma City
Lane-Wells Canadian Co. in Canada
Petro-Tech Service Co. in Venezuela



Drilling and Completion Practices in the Church Buttes Field

By W. C. DINGER
Petroleum Engineer
Mountain Fuel Supply Company
Rock Springs, Wyo.



General view of a typical lease in the Church Buttes field, showing well at right, and at left the heater-treater which increases gas temperature to prevent hydrate formation.

ONE of the deepest and highest pressure gas fields in the Rocky Mountain area is the Church Buttes field, owned jointly by Mountain Fuel Supply Company and Union Pacific Railroad Company, with the former serving as operator in charge of drilling and development. The field is an anticlinal structure discovered by seismograph surveys conducted in 1941, although the discovery well was not drilled until April, 1946. Producing horizons are at 12,433-13,053 feet, with the productive capacity of the producing wells ranging from 3 million to 15 million cubic feet of gas per day. Flowing pressures range from 3000 to 4500 pounds per square inch, and the liquid content of the gas varies from 6 to 8 barrels per million cubic feet.

The Church Buttes field is 50 miles west of Rock Springs, Wyo., and 3¾ miles south of Lincoln Highway U. S. 30-S, and is situated across the line between Sweetwater and Uinta counties.

The geological and geophysical work was done on this area before the acreage was unitized, and the unit agreement was completed prior to drilling the first test. Union Pacific Railroad Company's interest is 49 percent, with the remaining 51 percent being owned by Mountain Fuel Supply Company.

Production was discovered in 1946 by the completion of Unit 1 at 12,666 feet in the Dakota sandstone. Eleven additional wells have been drilled and a hydrocarbon removal and dehydration plant has been completed since that time. Of the 12 wells drilled in the field, three have been nonproductive.

Field Geology

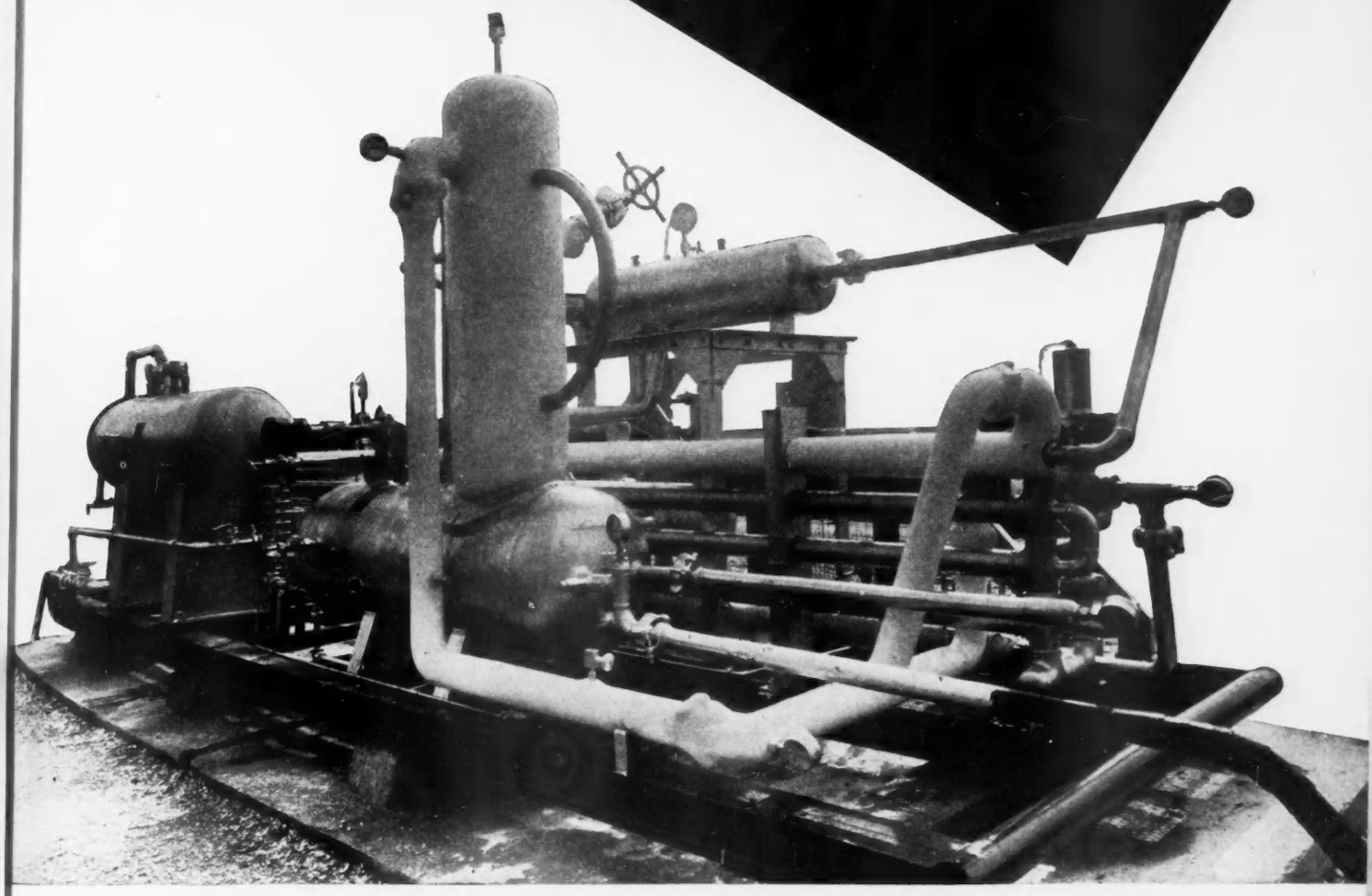
The Church Buttes gas field is an elongated anticlinal structure approximately eight to nine miles long and three to four miles wide, trending in a north-south direction. The Dakota sandstone of Cretaceous age is encountered at 12,400 to 13,000 feet in three main zones separated by relatively thin shale sections. The Frontier sandstone, above the Dakota and separated by the Aspen shale, has been cored and tested but commercial production is not present in this formation. The Nugget sandstone, at approximately 14,500 feet, also has been cored and tested but salt water was recovered in the drill-stem test. No major faulting has been found in the structure by drilling. A generalized stratigraphic section of the formations penetrated is shown in Figure 2.

The reservoir sandstones of the Dakota formation are of Cretaceous age. The three main sands are light gray, fine to coarse, hard to soft, and are separated by light gray, bentonitic, hard shales which have a tendency to cave. The sands are very well consolidated, and they range from 115 to 173 feet aggregate net thickness in well bore exposures.

Core data consist of complete analyses of all three zones. Average porosity of the reservoir sands in the wells drilled ranges from 8 to 21 percent and the permeability variation is appreciable, with individual values ranging from 14 to 750 millidarcys

WHAT HAS HAPPENED since the discovery in 1946 of one of the deepest and highest pressure gas fields in the Rocky Mountains is ably discussed. A field map and generalized stratigraphic section are included. This paper was presented before the Spring Meeting of the API at Casper, April 19-20, 1951.

HYRECO PAYS OUT FAST.....



with increased earnings from increased condensate recovery

When you put your gas well on production, the usual thing is to set a separator and, if necessary, install a heater to prevent freezing of controls and lines.

For only a few more dollars you can install a Parkersburg Hyreco Unit. But, and this is important, Hyreco quickly pays-out this slight additional cost. And, in considerably less time than it takes to recover the cost of your conventional heater-separator hook-up Hyreco pays-out completely, and from then on, earns big returns on your investment.

Why? Hyreco increases condensate recovery by 10% to 25% . . . and more . . . over conventional hook-ups. Hyreco eliminates the cost of operating a heater throughout the life of a high pressure gas well. Hyreco eliminates expensive downtown due to freezing. In almost every case, Hyreco eliminates the need for dehydration units to prepare gas for delivery to pipe line companies.

Your Parkersburg Representative has comparative records that prove Hyreco increases condensate recovery . . . increases earnings that make it pay-out fast. Ask him about them or write to us in Parkersburg for details.

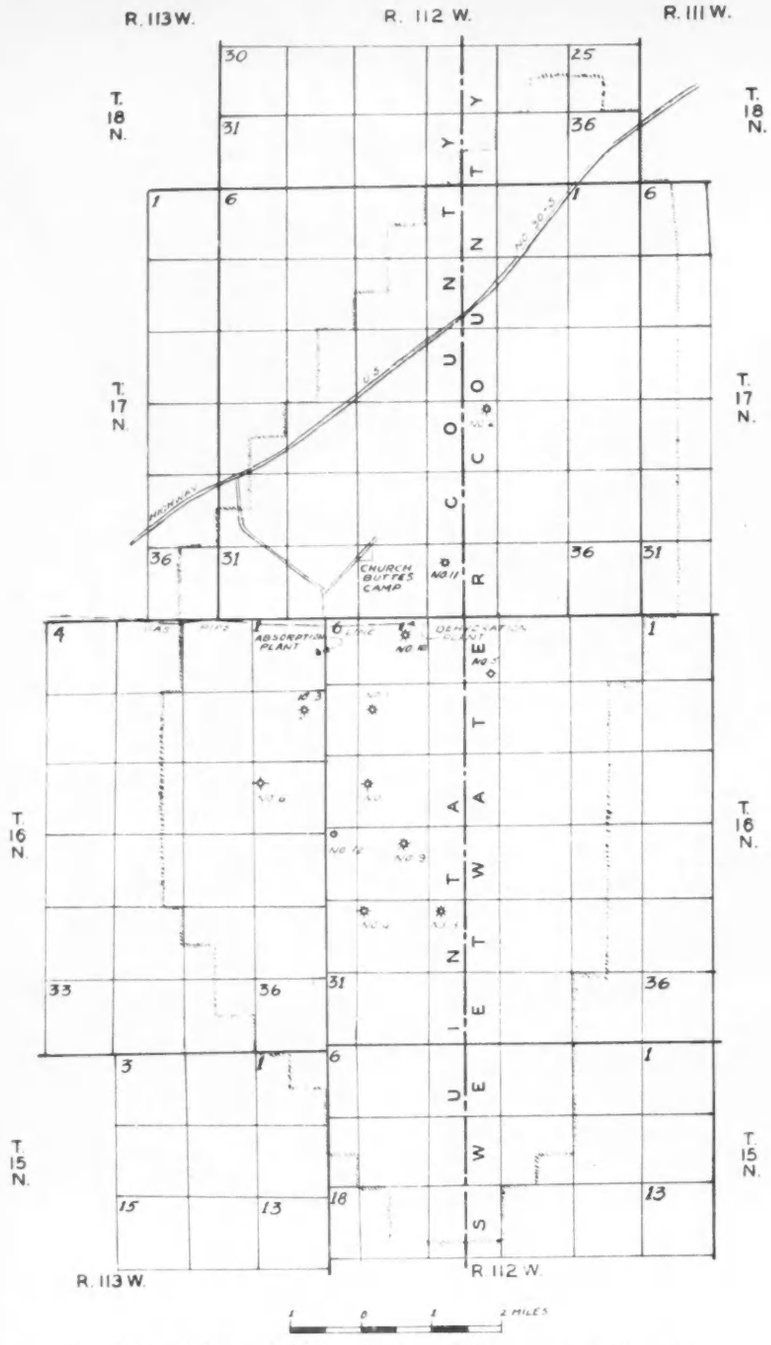
5107

PARKERSBURG

PRESSURE EQUIPMENT

HORIZONTAL AND VERTICAL SEPARATORS • HYRECO • HYDRACEPTER • SCRUBBERS • TREATERS • HEATERS

Manufactured in Houston, Texas



Map of Church Buttes field, Sweetwater and Uinta counties, Wyoming.

Generalized Stratigraphic Section Church Buttes Field, Sweetwater and Uinta Counties, Wyoming

TERTIARY:	
Bridger Form., 1235 Ft.	Green, gray and tan shales and sandstones, in part bentonitic and numerous thick beds of volcanic ash.
Green River Shale, 1735 Ft.	Greenish gray calcareous shale, with interbedded white to light gray limestone, calcareous sandstone, and oil shale.
Wasatch Form., 2090 Ft.	Gray, brown and red shale, in part sandy, with lenticular bodies of medium-grained light gray sand.
Fort Union (?) Form., 1890 Ft.	Light to dark gray shales, in part sandy and carbonaceous with numerous beds of light gray medium-grained sandstone, and some coal.
CRETACEOUS:	
Adaville Form., 1498 Ft.	Light to medium gray, fine to coarse, slightly carbonaceous sandstone, interbedded with gray sandy shale, and numerous thick seams of coal.
Blair Formation, 739 Ft.	Upper part essentially dark gray, silty to sandy shale, lower part is mainly light gray coarse sandstone with interbedded shale.
Hilliard Shale, 2923 Ft.	Medium to dark gray, silty to sandy, calcareous shale with thin beds of limestone and fine-grained sandstone.
Frontier Sandstone, 75 Ft.	Upper part is mainly dark gray, silty to sandy, partly carbonaceous shale with some thin coals. Lower part is light gray, medium-grained, hard tight sandstone.
Aspen Shale, 375 Ft.	Dark gray to black, dense to silty, calcareous shale, with frequent beds of light gray, hard bentonite.
Dakota Sandstone, 224 Ft.	Light gray fine to coarse, hard to soft sandstone, separated into three main zones by light gray, bentonitic, smooth to sandy, hard shale. Producing gas zone.
JURASSIC:	
Morrison Form., 700 Ft.	Green, gray, purple, red, dense shale, with thin beds of light gray hard sandstone.
Curtis Formation, 103 Ft.	Dark gray and greenish-gray, oolitic, glauconitic, limestone.
Entrada Formation, 140 Ft.	Brick-red, siltstone and silty shale.
Carmel Form., 612 Ft.	Interbedded dark gray, limestone, pink gypsum, and gray, red and green gypsiferous shales.
Nugget Sandstone, 129+ Ft.	White, fine to medium-grained, cross-bedded sandstone.

in the producing sections. It is very difficult to correlate stratigraphically the three main sands because of lenticularity in the Dakota formation and the variation in porosity and permeability. Part of the sands have permeabilities of less than one millidarcy, but these are not considered commercially productive since a section of this nature was perforated and tested in one of the wells.

Reservoir Fluids

The original fluid saturations in the Dakota sands range from 41 to 56 percent water, and from a trace to 3 percent oil saturation. The fluids as recovered at the plant range from six to eight barrels of condensate and one to two barrels of water per million cubic feet of gas produced. The condensate has a tank gravity of 53 degrees API. At the time of the discovery the pressure in the reservoir was about 7040 pounds per square inch at the datum depth of minus 5835 feet subsea, and the temperature was 250° F. After completion of Unit 1, surface samples of the liquid and gas were studied to determine the properties of the samples when recombined in the produced ratio and under the pressure and temperature of the reservoir. It was found from these tests that the reservoir gas is a retrograde gas and that no hydrocarbon liquid is present in the reservoir.

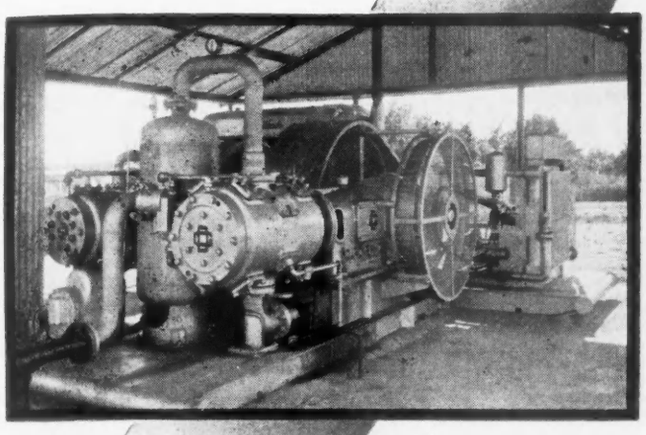
Field Development

Drilling is relatively uncomplicated in this area as there are not any of the hole difficulties encountered, such as crooked holes, lost circulation, or drilling mud problems. A 12¼-inch surface hole is drilled and opened to 17½ inches with 250 to 300 feet of 13⅜-inch casing set and cemented to the surface. The only disturbance in the mud is encountered when the trona beds in the lower Green River formation are drilled at 2600 to 2800 feet. Trona is essentially sodium carbonate, which increases the pH, viscosity and gels of the mud. However, additions of water and chemicals to lower the pH of the mud are made without any difficulty.

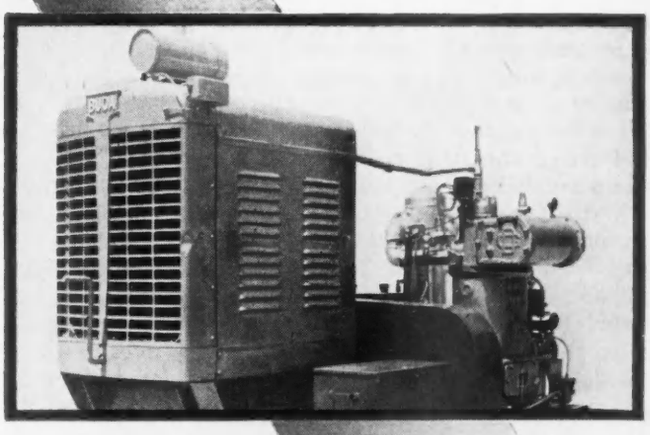
The intermediate string of casing is 9⅝-inch outside diameter, 6000 feet long and cemented with 600 sacks in a 12¼-inch hole. As the float collar and cement plug are being drilled, the drilling mud is converted to a calcium base mud using lime and calcium ligonsulfonate. Crude is also added to emulsify the mud and used to total depth in drilling the 8⅝-inch hole.

Before the 6⅝-inch production string is brought to the well, each

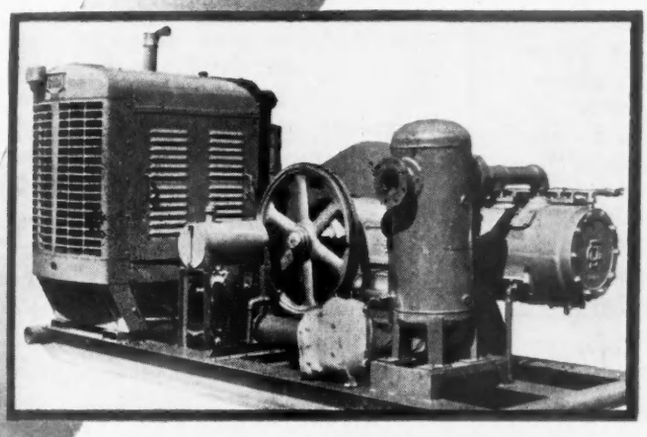
FOR EVERY PRESSURE CONDITION . . .



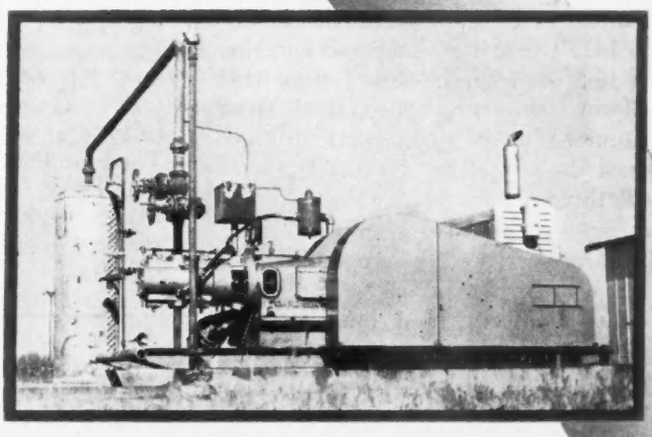
Gas engine driven 12 and 6 x 13 compressor for re-pressuring service



Engine driven model ABE for re-pressuring or booster service



Engine driven 8 x 9 booster compressor



Engine driven 5½ x 9 booster compressor

THERE'S A GARDNER-DENVER ANSWER!

Gardner-Denver packaged booster compressor units are made in a wide range of capacities and pressure ratings, from 5 to 275 horsepower.

These booster compressor units . . . featuring world-famous Gardner-Denver compressors . . . are available as portable or stationary units; with electric or gas engine drive; in single-stage or two-stage units; and with vertical or horizontal compressors.

Visit your nearest Continental store or office today . . . or write for bulletin.

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER

CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

THE CONTINENTAL SUPPLY COMPANY, *General Offices:* DALLAS, TEXAS

***Export Division:* The Continental Supply Co., Inc., 30 Rockefeller Plaza, New York, N. Y.**
The Continental Supply Company, Limited, 216 Lancaster Building, Calgary, Alberta

Representatives: ARGENTINA • BOLIVIA • BRAZIL • CHILE • COLOMBIA • ENGLAND • ECUADOR • PERU • TRINIDAD • URUGUAY • VENEZUELA

joint is hydrostatically tested to 6000 pounds psi for one minute.

In the first wells drilled the production string was set through the sands and the zones perforated. However, it is now the practice to set on top of the Dakota, drill out, and hang a slotted liner. The production string is cemented with 650 sacks, using centralizers, and a temperature survey is run to determine the top of the cement behind the casing.

Before the float collars and/or plugs are drilled, each string of casing is tested for one hour. The 13⅜-inch casing is tested to 1500 pounds psi, the 9⅝-inch tested to 2500 pounds psi, and the 6⅝-inch production string tested to 5400 pounds psi. In these tests, that part of the Christmas tree involved is also tested and the tubing head is tested with water to 10,000 pounds psi prior to installation.

In drilling the wells to this depth, 120 to 125 days are required and the number of rock bits varies from 136 to 147. The drilling time and number of bits have been reduced since the oil emulsion mud has been used. Diamond coring is used for all drilling from the top of the Dakota through the three main sands, and usually requires two or three diamond heads.

Earlier wells were completed with a packer on the tubing with the annulus filled with mud, but the later wells were completed without the packer. If corrosion should develop in the tubing, then it would be possible to lubricate the corrective chemicals into the annulus. In the tubing calipher surveys that have been run, there is no conclusive evidence that corrosion is taking place. Also, samples of water from the plant have been tested for iron content increases, but these data are not conclusive.

About the Author

W. C. DINGER joined Mountain Fuel Supply Company as petroleum engineer in the Church Buttes field in March, 1950, and has since concentrated on drilling and production practives in this area. He was graduated from the University of Oklahoma in 1936 with a B. S. degree in petroleum engineering after working as a roughneck and roustabout during the summer months prior to graduation. He worked as a warehouseman and sales engineer for Parkersburg Rig & Reel Company in Oklahoma and Texas from 1937 to 1944, at which time he joined The Pure Oil Company at Houston. From January, 1945, until March, 1949, he was drilling and production engineer for Houston Oil Company of Texas.

The tubing is hung 30 feet above the liner hanger, mud displaced with water and the wells completed. After the wells are completed and the drilling derricks are removed the valves of the Christmas trees are fitted with extensions and blow-off lines in case of emergencies at a later date.

Bottom-hole pressures are taken taken immediately after the wells are cleaned and before being put on production. Also, reservoir pressures are taken yearly on all wells to determine the amount of pressure decline in the reservoir for the amount of gas produced since the preceding survey.

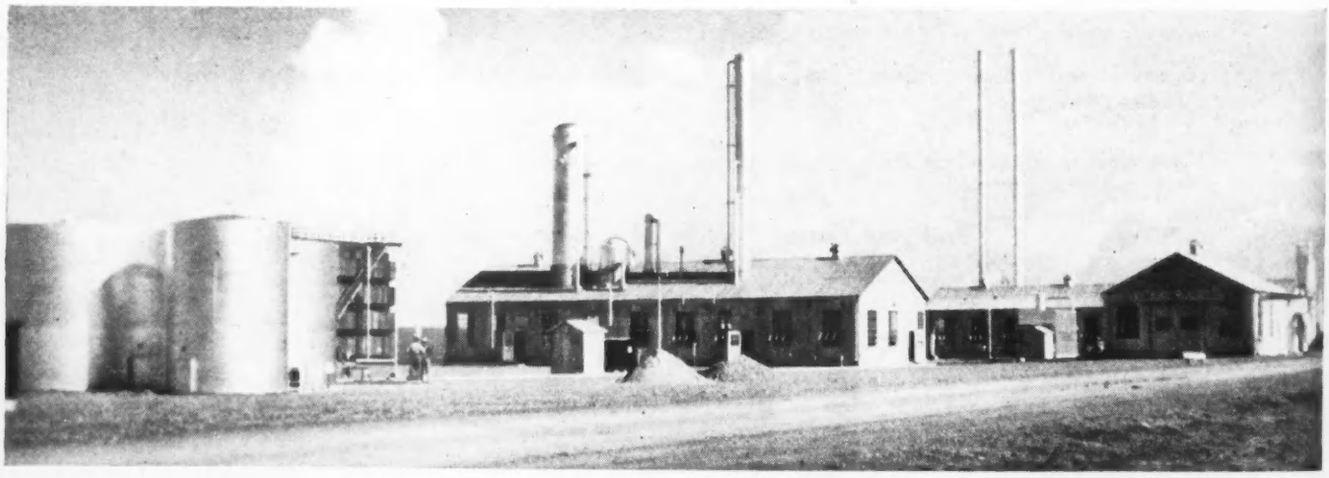
Initial shutin surface pressures are 5400 pounds psi, and the flowing pressures vary from 3000 to 4500 pounds psi, depending on the rate of flow. The first reduction in the wellhead pressure is taken after the gas travels a short distance and through one side of a two-pass indirect heater. After the gas expands through the adjustable choke, it is again reheated as it travels through the second pass of the heater. It then enters the meter house on the downstream side of the heater.

It is necessary to install the heaters near the wells to prevent the formation of hydrates in the flow lines due to the cooling on expansion to the flow line pressures. The pressure on the flow lines to the plant is 950 psi, and the hydrate point at this pressure is approximately 64° F. On the longer flow lines it is necessary to install intermediate heaters to prevent the flowing temperatures of the gas from decreasing to this temperature. All flow lines are buried six feet below ground and accurate records are kept of the daily temperatures at critical points to maintain the temperature of the gas above the hydrate temperature.

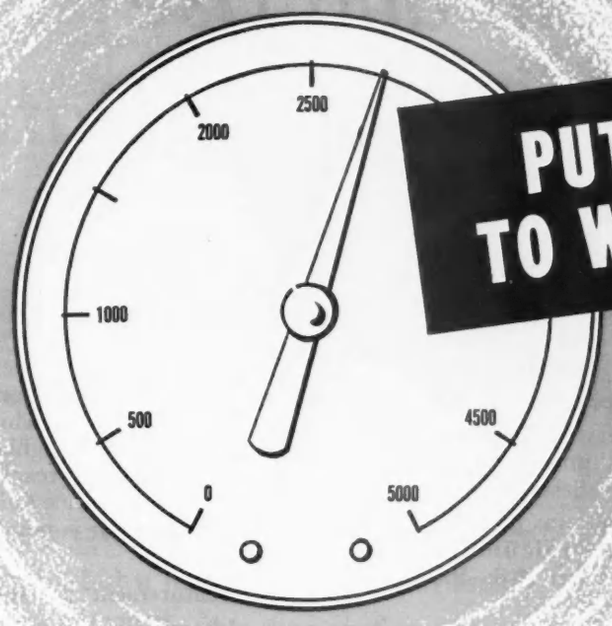
The gas enters the plant at this pressure, the hydro-carbons and water are removed, and then the gas enters the main line to northern Utah at a pressure of 450 pounds psi.

ACKNOWLEDGMENT

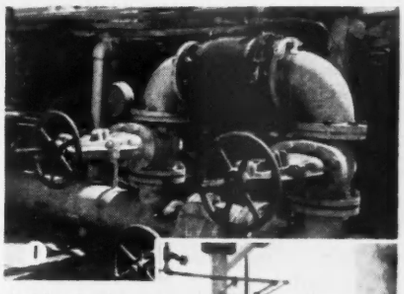
The author wishes to express appreciation to W. T. Nightingale and Mountain Fuel Supply Company for having granted permission to prepare and publish this paper and the valuable assistance rendered by J. T. Simon, chief petroleum engineer, and M. M. Fidlar, chief geologist, of Mountain Fuel Supply Company.

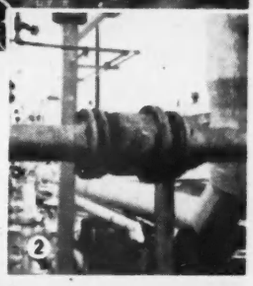


Natural gasoline plant in the Church Buttes field to extract liquid hydrocarbons from the wet gas produced in this high-pressure Rocky Mountain field.

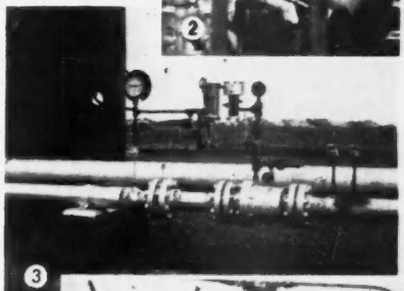


PUT PRESSURE TO WORK FOR YOU





1. Reliever holding back pressure on gas line.
2. Chexflo in gas compressor discharge line.
3. Flexflo automatic shut-off in gas line to heater.



by standardizing... on GROVE valves and regulators

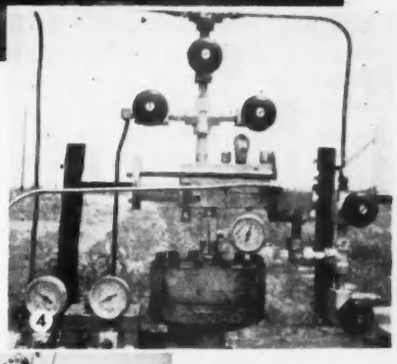
Properly controlled and applied fluid pressures, rather than the mechanical forces of springs, weights or packings, are the outstanding features that characterize Grove designs and products.

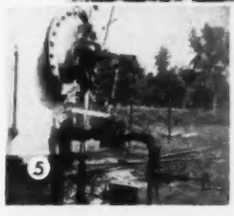
The Grove Powreactor Dome principle has revolutionized the design and construction of regulators for high pressure gas, air and other fluids, by eliminating cumbersome springs, weights and levers.

Flexflo and Chexflo valves, resulting from Grove studies of the action of enclosed expanding tubes, effect a positive and unfailing operation never before achieved in the control of pipeline fluids.

The "O" ring Seat-Seal principle, embodied in "T" and "V" series globe-type valves and "F" and "M" series slide valves, has greatly increased the field of usefulness and the pressure ranges of these valve types.

The products illustrated are only a few examples of the flexibility and adaptability of all these exclusive Grove developments. For your control problems, too, Grove can provide regulators and valves of unequalled reliability. Contact the nearest Grove office today, or address your inquiry to:





4. Well Head Protection System, T-series Seat-Seal Valves in manifold.
5. Model 899 Separator Oil Valve.

GROVE REGULATOR COMPANY

1901 CALUMET ST., HOUSTON 4, TEXAS • 6529 HOLLIS ST., OAKLAND, CALIF.

Measurement and Use Of Relative Permeability Data

By UZZELL S. BRANSON, JR.
James A. Lewis Engineering, Inc., Dallas

AN UP-TO-DATE way to measure relative permeabilities to oil, gas and water in the laboratory is described in detail.

This paper was presented before the Petroleum Branch, AIME, October 4-6, 1950, in New Orleans.

RELATIVE permeability-saturation data may be obtained by laboratory measurements on small core samples. Examination of the variation in calculated recovery using data obtained on samples from different fields indicates the importance of accurate relative permeability data in predicting reservoir performance. Combining relative permeability data with core analysis, subsurface sample analysis, and reservoir configuration, well and reservoir performance may be calculated and production practices selected to result in the maximum economic recovery of oil from a given reservoir.

Importance of the permeability of reservoir rock in determining productivity is generally recognized in a qualitative fashion. The property normally measured in routine analyses of core samples is the specific permeability of the medium to air. The specific permeability is a measure of the fluid conductivity of the medium completely saturated with the fluid under consideration. If the results of interactions between medium and fluid to alter effectively the pore structure be excepted, the specific permeability is a property of the medium.

The fundamental equation expressing the rate of flow of an incompressible fluid through a porous medium was developed empirically by Darcy. The radial flow equation,

$$Q = \frac{3.07\ kh\ (Pe - Pw)}{\mu \log r_e/r_w}$$

(Nomenclature given at end of paper.)

is widely used in engineering calculations designed to describe or predict the behavior of hydrocarbon producing reservoirs.

One of the factors complicating the prediction of reservoir behavior is the heterogeneity of the fluid system. The specific permeability as a unique property of the fluid-rock system is not applicable under practical operating conditions and must be modified by the permeability-saturation relationships. The growing interest in these permeability-saturation relationships is evidenced by the large number of papers[1,2,3] that have appeared recently in the literature.

Permeability-saturation relationships may be expressed as effective permeability, the conductivity of the system with regard to one fluid phase in the presence of others. Effective permeability is expressed in millidarcys as is specific permeability, but has varying values depending on the saturation and the nature of the fluids and medium concerned. Thus, a sample of a medium 100 percent saturated with oil might have a specific permeability of 200 millidarcys; but with 30 percent water and 70 percent oil the effective permeability to oil might have dropped to 160 millidarcys; and in a third case 30 percent water, 20 percent gas and 50 percent oil, the effective permeability to oil might be 40 millidarcys. In addition to the effective permeability to oil, two other effective permeabilities could be present in the last case, i.e. effective permeability to water, 5 millidarcys, and to gas, 60 millidarcys.

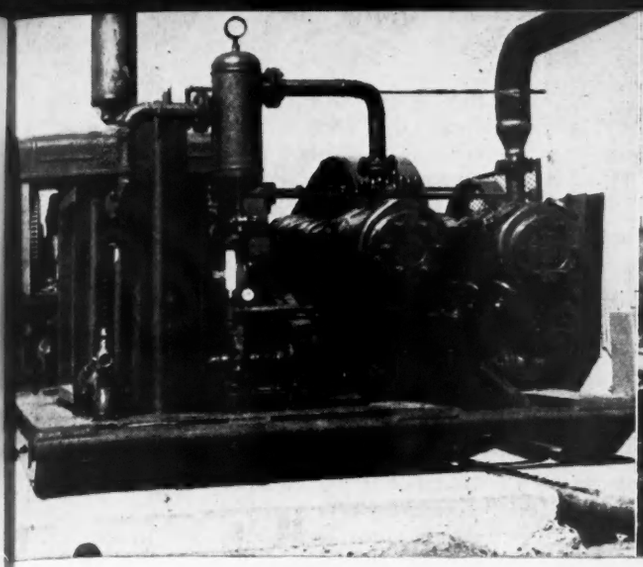
For most reservoir analyses the effective permeability is not used as such, but rather as the ratio of the effective permeability at the given saturation to the specific permeability of the medium. This ratio is called the relative permeability, (Kr). In the examples given in the preceding paragraph, relative permeability to oil (Kro) in the first case would be 1.00; in the second case, 0.80; and in the third case, 0.20. Relative permeabilities to the other fluids in the third case would be, to water (Krw) 0.025, to gas (Krg) 0.30. Over most of the range of saturations considered the sum of the relative permeabilities is less than one. An exception to this is the case of the Krg, which at gas saturations in the neighborhood of 80-100 percent, often reaches a value of unity. Flow of other fluids in such a saturation region is nearly zero.

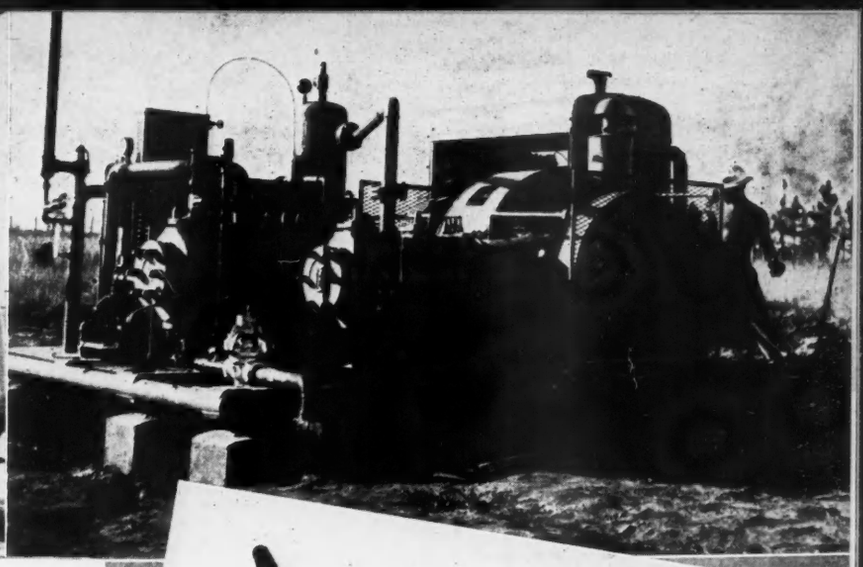
Measurement of Relative Permeabilities

Relative permeability measurements discussed in this paper are made with only the fluid under consideration being allowed to move. The determination of relative permeabilities to gas and to liquid require different apparatus and techniques and are discussed separately.

A small cylindrical sample, approximately 2 centimeters in diameter by 2 to 3 centimeters in length is cut from the sample with a diamond core drill. The ends are ground flat. The sample is dried in an oven at a temperature of 80 to 90° C and then extracted by forcing 50 to 100 pore volumes of carbon tetrachloride or of a mixture of carbon tetrachloride and pentane through the core, or by carbon tetrachloride in a soxhlet extractor. The cleaned sample is dried, weighed, its dimensions determined with a caliper, and its permeability to air determined.

The sample is placed in a test tube attached through an acetone-carbon dioxide trap to a high vacuum pump. A pressure below one millimeter of mercury is maintained in the saturation cell for 30-60 minutes depending on the permeability of the sample. The saturating fluid is then dropped in slowly allowing the core sample to become wet by capillarity. When the surface of the sample is wet, fluid is allowed to enter until the core is covered to a depth of two to three centimeters. The vacuum is maintained for about 15 minutes after which the container is opened to atmospheric pressure and the samples allowed to sit until ready for use, usually overnight or longer. When the samples are removed from the fluid, excess liquid is wiped off and the





The Compressor installations shown on these two pages are but a few of the many that testify by their continuous trouble free performance to the engineering "Know How" of not only the manufacturer but Wilson Supply Company in the proper assembling and mounting the equipment on heavy skids.

Remember — these "Packaged" Portable units take the place of far more costly, permanent installations and should the occasion later require, are easily moved to any other desired location.

What are your compressor needs? If it's Gas-Oil Lift, Repressuring, Booster work—you will find there is a Wilson Supply-Ingersoll-Rand "Packaged" Portable Compressor made to best meet your specific requirements.

Contact your nearest Wilson Supply Company Store or write "Compressor Division," Wilson Supply Company, P. O. Drawer 19, Houston, Texas, for detailed information, and quotations. Please give suction and discharge pressure and volume to be handled.

WILSON SUPPLY COMPANY

BRANCH STORES
Texas—Alice, Corpus Christi, Victoria, Bay City, Columbus, Barbers Hill, Liberty, Beaumont, Kilgore, Monahans. Louisiana—Lake Charles, New Iberia, Houma, Harvey, Shreveport.

1412 Maury St.
HOUSTON
TEXAS

Sales Offices:
DALLAS, TEXAS
TULSA, OKLAHOMA
NEW ORLEANS, LA.

sample is placed in a weighing bottle. From the gain in weight, specific gravity of the saturating fluid, and dimensions of the core sample, porosity is calculated. Porosities determined by a series of such saturations using different liquids rarely vary more than one to three-tenths of one percent. The saturation of such samples has been checked by placing them under the saturating liquid at pressures up to 1000 pounds per square inch gauge. No appreciable additional liquid can be forced into them.

Relative Permeability to Gas and Oil

Since the relative permeability to gas (Krg) measurements leave the sample clean, they are run first. Isooctane is usually used as the liquid phase. The sample is mounted in a core holder, and air is flowed through it under a differential pressure of 50 to 150 millimeters of water. Time is measured with a stopwatch, flow by the movement of a soap film in a pipette. The sample is weighed before and after each flow reading, and the saturation assumed to correspond to the average weight during the measurement. A series of such flow rate-saturation points are determined as the sample is desaturated by evaporation, relative permeability calculated by dividing the flow rate at each point by the flow rate at 100 percent gas saturation, and a curve of Krg versus liquid saturation drawn. Variations of relative permeabilities to gas within one field is illustrated in Figure 1, between average values for several fields in Figure 2.

All relative permeability to oil (Kro) measurements discussed in this paper were made using special grade kerosine as the oil phase. This kerosine has been found to be consistent in its properties, free from substances that form gums and change the nature of the liquid during the measurements. Each batch is stripped of its lower boiling components by keeping it under a vacuum for 8 to 24 hours prior to use.

The apparatus used in measuring relative permeability to oil is shown schematically in Figure 3. It is essentially two pipettes, V_1 and V_2, for measuring the flow out of and into the sample, a manometer G to measure the pressure drop across the core sample, a pressure control apparatus represented by manometers A_1 and A_2, a calibrated reservoir R, and the capillary contacts F. A cross-section of the contacts is shown on the diagram. They consist of diatomaceous earth flow rings and pressure buttons cemented to lucite cylinders. The flow path in the system is from pipette V_2 through the ring on the capillary contact on the right to the core sample. From the core sample kerosine passes through the left flow ring into pipette V_2. The manometer G is connected to the core through the diatomaceous earth buttons in the center of the contacts. When steady state flow is attained the pressure at each end of the sample is constant and no fluid is flowing in the manometer system, thereby minimizing pressure drops due to discontinuities in the system. The reservoir R is connected through the stopcocks C_1 and C_2 to permit adding kerosine to V_2 and withdrawing it from V_1. Kerosine removed from the core in the desaturation process is drawn into the reservoir. The saturation in the core may be calculated at each step from the increase in the volume of kerosine in the reservoir.

The saturated sample is mounted between the capillary contacts and the pressure on each side of the sample reduced to one to five millimeters below atmospheric. The amount of the reduction depends on the permeability of the sample, care being taken not to exceed the threshold pressure. When the system reaches equilibrium, shown by the liquid in the pipettes being stationary, the volume of kerosine in the reservoir is recorded.

The pressure in A_1 is then reduced slightly and kerosine permitted to flow through the sample until the system is again in equilibrium. At equilibrium the rate of flow is the same in both pipettes and the manometer is no longer changing. From the rate of flow and the manometer reading, the flow rate per unit pressure drop is calculated. Gas saturation in the core sample is calculated from the amount of kerosine withdrawn from the sample. During the first few points the change in saturation is usually negligible, so they serve as initial or 100 percent oil saturated flow rates. Flow rates measured at reduced saturations are divided by the average of the values measured before any desaturation was observed to obtain the relative permeability.

After the pressure has been reduced below the threshold pressure, kerosine

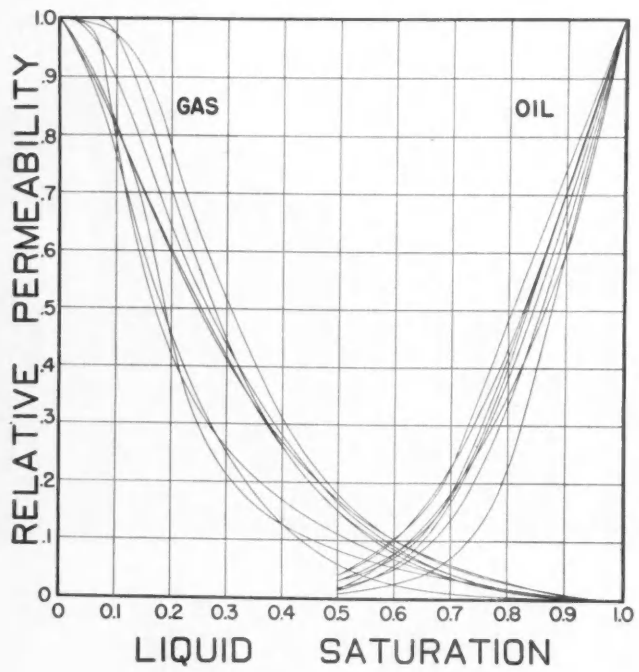


FIGURE 1. Relative permeabilities from one field.

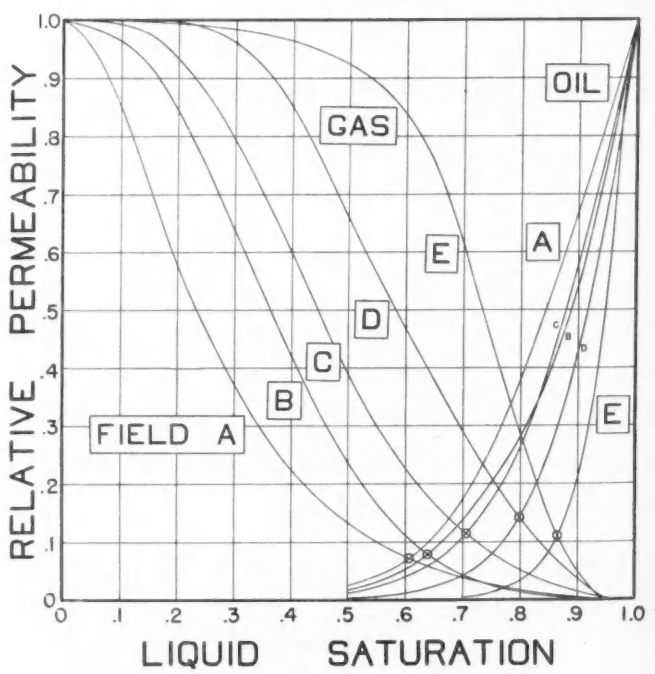


FIGURE 2. Typical relative permeabilities.

is forced out of the core sample by atmospheric pressure. A series of points are taken at various pressures until the oil saturation in the core has been reduced to the desired value. From the flow rates obtained and the volumes of kerosine withdrawn from the core, the relative permeability-saturation relationship is calculated. Figure 1 shows relative permeability to oil curves for eight samples from one field. A comparison of average relative permeability curves from several fields is shown in Figure 2.

Three-Phase Relative Permeability to Oil

Measurements of relative permeability to oil in the presence of connate water are made on the same apparatus and in the same manner as the two phase runs discussed above except the contacts are made hydrophobic by treating with dri-film or coating them with graphite. Measurements made with water present in the sample require longer times to reach equilibrium at any given liquid saturation than do the two phase runs.

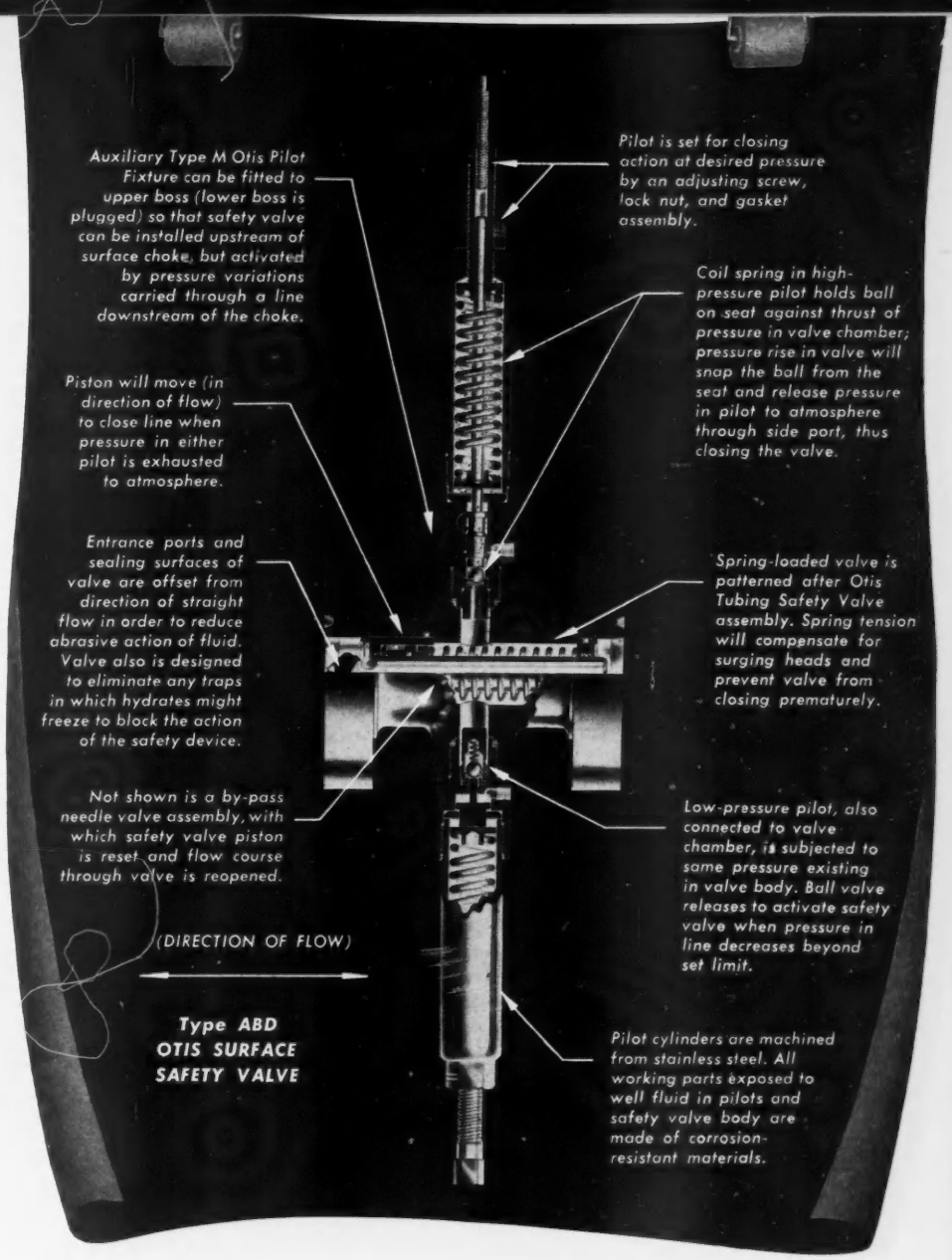
A method has been devised to calculate three-phase data from the two-phase data. The two-phase relative permeability to oil is scaled down by a quantity that is a function of water saturation and relative permeability to gas. This first approximation is further modified by a correction that is a function of total liquid saturation, two-phase relative permeability to oil and an empirical constant taken from results of three-phase measurements.

A comparison of measured and calculated three-phase relative permeabilities together with the two phase run on the same sample are given in Figure 4. The three curves were reduced to a value of unity at 100 percent liquid saturation for comparison.

Only one point on the relative permeability to water curve was measured; the relative permeability at the end of a flood test. The samples are treated as they would be in any flood test, saturated with brine, flushed out with oil and then flooded until no further oil is recovered. The permeability to brine is measured at this residual saturation and divided by the permeability at 100 percent brine saturation. Where available, reservoir brine, crude, and proposed flood water are used in these tests. If they are not available, kerosine and synthetic brines are used. An ordinary water permeameter is used in the measurements.

Uses for Relative Permeability Data

Relative permeabilities discussed in the preceding paragraphs are used in


Auxiliary Type M Otis Pilot Fixture can be fitted to upper boss (lower boss is plugged) so that safety valve can be installed upstream of surface choke, but activated by pressure variations carried through a line downstream of the choke.
Pilot is set for closing action at desired pressure by an adjusting screw, lock nut, and gasket assembly.
Coil spring in high-pressure pilot holds ball on seat against thrust of pressure in valve chamber; pressure rise in valve will snap the ball from the seat and release pressure in pilot to atmosphere through side port, thus closing the valve.
Piston will move (in direction of flow) to close line when pressure in either pilot is exhausted to atmosphere.
Entrance ports and sealing surfaces of valve are offset from direction of straight flow in order to reduce abrasive action of fluid. Valve also is designed to eliminate any traps in which hydrates might freeze to block the action of the safety device.
Spring-loaded valve is patterned after Otis Tubing Safety Valve assembly. Spring tension will compensate for surging heads and prevent valve from closing prematurely.
Not shown is a by-pass needle valve assembly, with which safety valve piston is reset and flow course through valve is reopened.
Low-pressure pilot, also connected to valve chamber, is subjected to same pressure existing in valve body. Ball valve releases to activate safety valve when pressure in line decreases beyond set limit.
(DIRECTION OF FLOW)
Type ABD OTIS SURFACE SAFETY VALVE
Pilot cylinders are machined from stainless steel. All working parts exposed to well fluid in pilots and safety valve body are made of corrosion-resistant materials.

X-Ray of a Type A
OTIS SURFACE SAFETY VALVE

This newest Otis safety valve provides a positive means of automatically shutting off a flowing well in case of a line break, freeze-up, or other emergency condition which might cause an increase or decrease in pressure beyond safe or practical limits.

It is recommended for trees, flow wings, gathering lines, etc., where full-opening gate valves are not required. It is a self-contained, fully automatic unit that is more economical and more dependable than personal supervision of flowing wells . . . protection against fire hazards, waste of oil and gas, and damage to nearby property and equipment. Ask the Otis office nearest you about other important operating features and for technical details and illustrated literature. There's no obligation whatsoever, and afterwards you'll be better informed on the better methods of safe production.

Otis Pressure Control, Inc.

Telephone DIxon-3911 • TWX DL-220
P. O. Box 7206 • Dallas, Texas

DALLAS • HOUSTON • CORPUS CHRISTI • VICTORIA • ODESSA • FALFURRIAS • LONGVIEW
OKLAHOMA CITY • ELK CITY • NEW IBERIA • HOUMA • BROOKHAVEN • CARACAS, Venez.

calculating well and reservoir performance. These calculations are based on the material balance method. As these calculations have been thoroughly discussed in the literature[4, 5, 6, 7] this paper is limited to an examination of the effect of variations in relative permeability data upon the calculated quantities.

The produced gas-oil ratio is one of the major factors in determining the recovery from a reservoir that is produced by gas drive. By combining the equation

$$Rp = \frac{Krg}{Kro} \times \frac{\mu o}{\mu g} \times \frac{uL}{v} + R_D$$

with the material balance equation, the gas-oil ratio at each stage in the depletion of a reservoir may be calculated. All of the quantities in the equation except the ratio Krg/Kro are obtainable from subsurface sample analysis and from the literature.

To illustrate the importance of using reliable relative permeability data in calculating recoveries by gas drive, sample calculations have been made. Results of three such calculations, with all properties except permeability ratio being held constant, are presented in Figure 6. The permeability ratio data used are shown in Figure 5 and is the data from fields designated as "B," "C," and "D" in Figure 2. Although the extreme cases "A" and "E" were not used, the variation in calculated recoveries to zero pounds per square inch reservoir pressure is from 10.4 to 24.5 percent of oil in place.

In an actual reservoir, the recovery to zero pressure is not the quantity desired. Of much more importance are the time-recovery relationships and the recovery to the economic limiting rate. The two factors chiefly responsible for the decline in productivity of a well producing from a gas drive reservoir are the pressure and relative permeability to oil.

Since the pressure and gas saturation at each stage in the depletion of a reservoir can be calculated by the material balance method, the radial flow form of Darcy's law can be modified by multiplying by the proper relative permeability fraction to give the productivity index at each reservoir pressure. The productivity index so obtained is the zero flow index and must be modified to account for drawdown.

An approximation of the effect of drawdown on productivity is made by assuming that the effective productivity index (PI′) is equal to the calculated productivity index at the average of the reservoir and well bore pressures. The effective productivity index so calculated has been found to give reasonable agreement with field data in a number of cases and also with other methods of approximating well productivity. Using this effective productivity index, the flowing pressure at the sand face at any given production rate and the cumulative production to any arbitrarily assumed limiting productivity can be calculated.

Calculations outlined in the preceding paragraph have been performed for the three cases discussed earlier. The limiting rate of production was arbitrarily set at ten barrels per day and the capacity of the well assumed to be 2000 millidarcy feet. The point at which the idealized well reaches its limiting productivity is shown by vertical lines near the bottom of the pressure decline curves in Figure 5. The calculated pressure on the sand face at a producing rate of 50 barrels per day, as well as productivity index and effective productivity index for field "C," are shown in Figure 7.

Importance of relative permeabilities discussed earlier in a field operating under water drive is dependent on the magnitude of the water drive. If the water drive is limited in nature, reservoir pressure may fall below saturation pressure. Under such conditions the reservoir will be producing by a combination of gas and water drives. If the magnitude of the water

About the Author

UZZELL S. BRANSON, JR., reservoir analyst with James A. Lewis Engineering, Inc., has B.A. and M.A. degrees from Hendrix College and the University of Arkansas and has done additional graduate work at the University of Chicago. His experience in the petroleum industry includes three years in the production research laboratories of Core Laboratories, Inc., and four years analyzing reservoir behavior for James A. Lewis. He is a member of ACS and AIME.

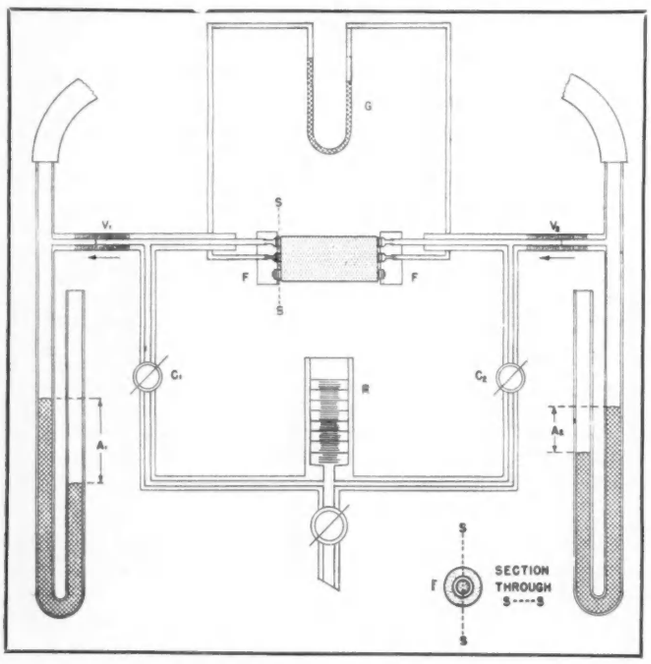


FIGURE 3. Relative permeability apparatus.

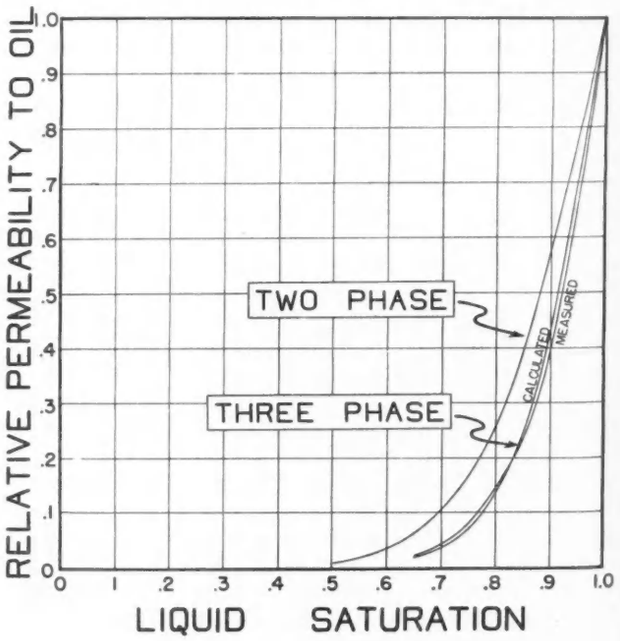


FIGURE 4. Two- and three-phase relative permeabilities.

drive is known, performance may be calculated by methods discussed in papers cited before. If relative permeability and the configuration of the oil bearing reservoir are known, the maximum possible natural water influx for a given pressure in the oil reservoir can be calculated. From this value the maximum oil rate that may be maintained without reducing reservoir pressure below saturation pressure is obtainable.

If the reservoir is so produced that the pressure remains above saturation pressure, the ratio Krg/Kro has no effect on the ultimate recovery, as no gas saturation exists. The ratio of the Krw in the watered out zone to the Kro in the oil zone is, however, an important factor in determining the water-oil ratio. In addition, the Krw in the flushed zone partially determines the rate of movement of water through the formation, and so the injection pressure and spacings required for satisfactory artificial water drive programs.

NOMENCLATURE

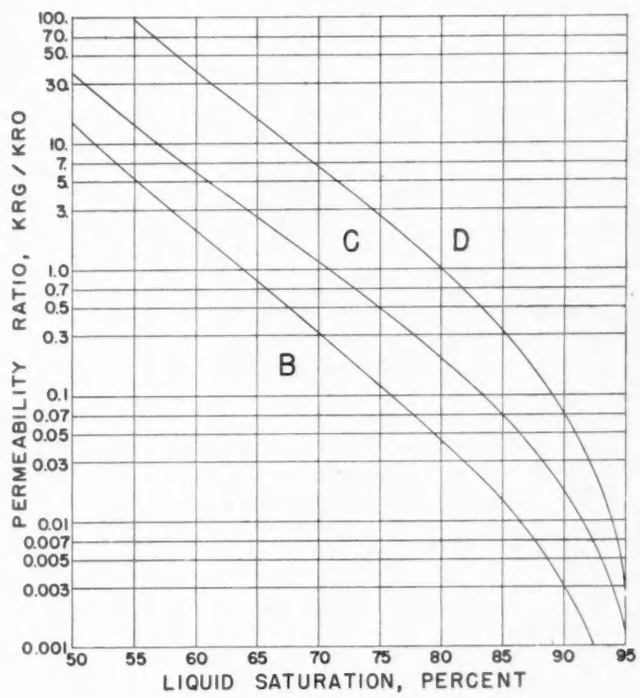
Q = Rate of flow, barrels per day
k = Permeability, darcys
h = Thickness, feet
P_e = Pressure at drainage radius, psi gauge
P_w = Pressure at well bore, psi gauge
μ_o = Viscosity of oil, centipoises
μ_g = Viscosity of gas, centipoises
re = Drainage radius, feet
rw = Well bore radius, feet
Kro = Relative permeability to oil, fraction
Krg = Relative permeability to gas, fraction
Krw = Relative permeability to water, fraction
Rp = Produced gas-oil ratio, cubic feet at standard conditions per barrel of stock tank oil
R_D = Solution gas-oil ratio, cubic feet at standard conditions per barrel of stock tank oil
u_L = Formation volume factor, barrels in reservoir per stock tank barrel
v = Gas volume factor, barrels in reservoir per standard cubic foot

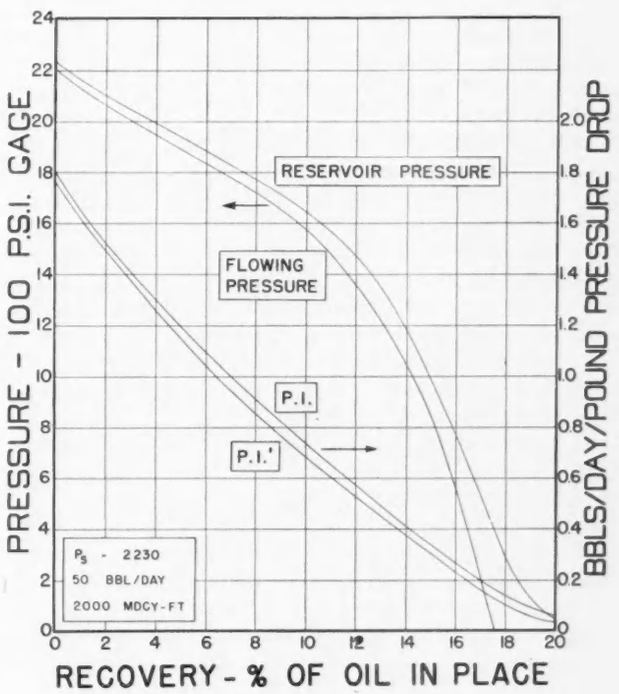
REFERENCES

[1] W. J. Leas, J. H. Jenks, and C. D. Russell: AIME Petr. Tech., March 1950.
[2] E. R. Brownscombe, R. L. Slobod, and B. H. Caudle: Oil and Gas Journal, 48, No. 40, 58, February 9, 1950.
[3] Walter Rose: AIME Pet. Dev. and Tech., 1949.
[4] R. E. Old: AIME Trans. (1943) 151, 86.
[5] E. C. Babson, Prediction of Reservoir Behavior from Laboratory Data, AIME Trans. (1944) 155, 120.
[6] W. Hurst: AIME Trans. (1943) 151, 57.
[7] R. W. Woods and M. Muskat: AIME Trans. (1945) 160, 124.

ACKNOWLEDGMENT

The author wishes to acknowledge the cooperation and assistance of James A. Lewis Engineering, Inc., Core Laboratories, Inc., and especially of Dr. F. C. Kelton in the preparation of this paper.





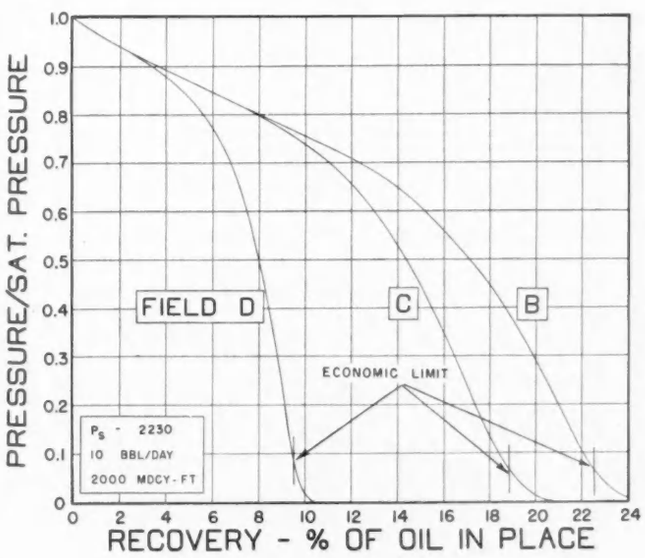


FIGURE 5 (top left). Permeability ratio.

FIGURE 6 (lower left). Pressure decline curves.

FIGURE 7 (top right). Pressure and productivity indices, Field "C."

Corrosion Fundamentals

In Field Application

By DR. ALFRED CHATENEVER

College of Engineering, University of Oklahoma, Norman

THE RELATION of fundamental corrosion theory as developed in the research laboratory to actual field practice is clarified to show how complicated studies bring about practical mitigation programs. Chemical and electrical theories of corrosion are briefly discussed, and a possible answer to the pitting problem is presented. The author ably demonstrates how scientific studies have brought about present anti-corrosion practices in the field, and shows that there remains much work to be done.

A QUESTION often brought up by operating personnel in present-day corrosion discussions is, "What good are laboratory theories to the practical man?" While theory does not offer all the desired solutions, it presents more than enough to warrant its consideration on a practical level. Consider the case of corrosion resulting from bimetallic junctions. Without the benefit of existing theory, a good many costly and inefficient investigations would probably be carried out to yield a few partial remedies which would be of small significance when compared with what is being accomplished. There would probably be a good deal of coupon testing which could not yield any information that would be directly applicable. With the thought of conditioning the process fluid, there might be extensive chemical analysis and further chemical corrosion tests. There might be experimental replacements in the structure with parts fabricated of special metals. Eventually, perhaps, a solution might come forth in the form of water conditioning to reduce the oxygen content or the salinity. Perhaps it would be decided that the metal should be coated with a paint or a special coating or that alloys of special composition should be used. Any of these procedures might be remedial to some extent. They are, however, grossly inefficient when compared with the solution that follows from the electrochemical theory. According to this, the best remedy would be that of fabricating the structure with uniform metal. Thus, instead of using a combination of black and galvanized iron together with brass and bronze, it would be desirable to use but one type of metal. This procedure is not only most often feasible but also sometimes results in reduced construction costs. Furthermore, it is by far a cheaper and more efficacious remedy than any of those mentioned above.

Similarly, it is conceivable that with the proper understanding of the nature of pitting, remedies could be designed on the basis of physical rather than chemical considerations. Thus, it might be advisable to use smooth pipe, or design structures to avoid the deposition of particles from the flow stream or take special care in the preparation of pipe joints especially threaded rather than install a conditioning system for the removal of oxygen.

Another use that theory finds in field practice concerns the classification of corrosion phenomena. At the present time the literature is filled with numerous reports of experiences with corrosion in the field. There are many more instances that go unreported. All of these are significant in that they present engineering data for analysis and generalization.

Before these data can be so ex-

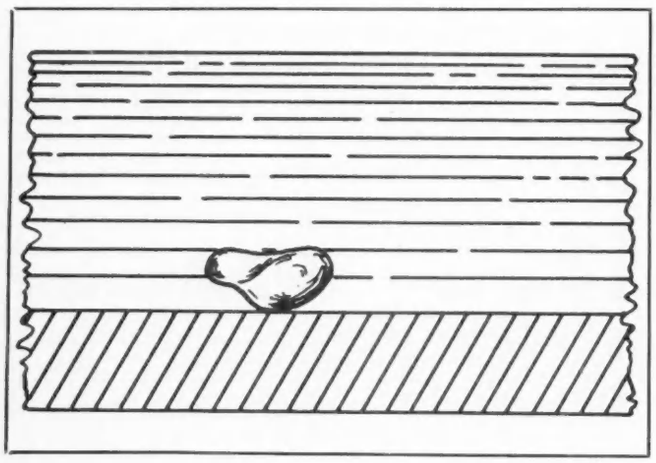


FIGURE 1. This sketch illustrates a particle of dirt resting on a metal surface in an aqueous solution.

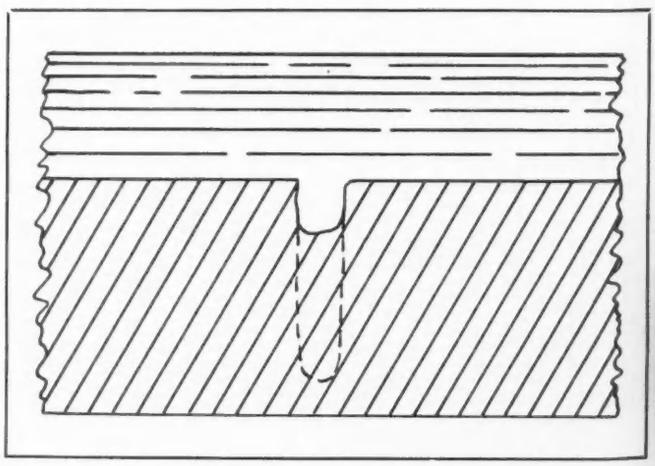


FIGURE 2. Pit development on a metal surface as indicated by broken lines due to different oxygen concentrations.

Now...Even Simpler Counterweight Adjustment!

Quicker than ever; only *two* nuts to loosen on the weight assembly of most models.

Note also that one crank position is sufficient for *all* counterweight adjustments.

Socket wrench is applied here to turn pinion. Action of pinion (geared to rack) shifts the weight to desired point.

When first presenting its Series 50 pumping units, Bethlehem introduced the simplest, easiest, safest counterweight adjustment ever devised for this type of machine. It was a feature that had thoroughly proved itself under many gruelling tests . . . and one that continued to prove itself in the field, where it met with immediate success.

And now—adjustment of the weights has been further simplified by using only two binding bolts per weight on units through the 54-in. stroke, three bolts on units with 64-in. stroke, and four bolts on units with 74-in. and 86-in. stroke. In all cases these bolts are "in line" so that they are even more accessible than on the earlier models.

The operator, after loosening the bolts, merely applies his socket wrench to the end of a pinion shaft. He moves the wrench gently, with little or no effort, and the weight shifts position. Numbered graduations on the crank, and an index on each outer counterweight shell, facilitate adjustment.

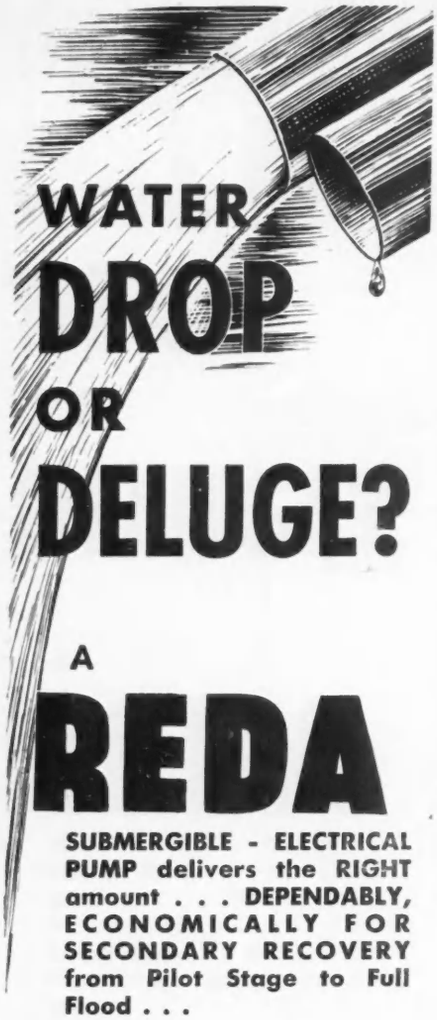
It's all so effortless and safe! No climbing or scrambling. The operator stays on the ground, and there's nothing that can fall from the unit and hurt him.

For more details, call Bethlehem Supply—the office or store nearest you. Information will be furnished promptly.

BETHLEHEM SUPPLY COMPANY

General Offices: 21 E. Second St., Tulsa, Okla.
West Coast Headquarters: Los Angeles, Calif.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL



WATER DROP OR DELUGE?

A REDA

SUBMERGIBLE - ELECTRICAL PUMP delivers the RIGHT amount . . . DEPENDABLY, ECONOMICALLY FOR SECONDARY RECOVERY from Pilot Stage to Full Flood . . .

ENGINEERING DESIGN

Reda Pumps produce the largest volumes obtainable from 5½", 7", 8⅝" casings, often reducing the required number of source wells. Corrosion resistance built into Reda Pumps materially prolongs time between pulling jobs, where corrosion is a factor.

ECONOMY

Reda Pumps reduce investment in number of supply wells required. Reda pumping equipment investment is less per barrel of daily capacity; pumping cost per barrel is lower.

FLEXIBILITY

To fit the changing needs for water volume as the flood progresses, Reda Pump can readily be altered or changed to larger or smaller sizes.

Reda Engineers have been closely associated with WATER FLOOD OPERATIONS for more than ten years and are fully qualified to assist operators in the selection of proper pumping equipment. A letter or phone call will bring prompt results.

REDA

PUMP COMPANY

•

BARTLESVILLE, OKLAHOMA

amined and compared, it is necessary to organize and classify them. Otherwise it might develop that rates of corrosion in various instances of oxidation and galvanic corrosion, for example, would be investigated for the purpose of arriving at a common mechanism; and, of course, there might not by any. It is in this connection that theoretical developments in corrosion serve well in providing a basis for these badly needed classifications.

There is a connection between the fundamental theory of corrosion and practice that is perhaps a little more subtle than the others. Accepting the validity and the success of the applications as indicated above, it follows that such basic studies should be actively pursued in the hope of arriving at further developments. The science of corrosion as it exists today, with its compiled data and its various theories, even though some of the latter might be in error, provides the necessary foundation for futher work.

The science of corrosion has reached an interesting stage of development. As a consequence of the obviously complicated nature of corrosion phenomena and the rather meager history of fundamental research in this connection, there is not yet a strong and broad fundation of basic principles supported by extensive experimental evidence. In its place are a number of theories and hypotheses, sometimes conflicting, which attempt to explain the great number of instances of corrosion that are continuously appearing in the field. A considerable amount of question surrounds the various existing theories. Nevertheless, an understanding of these generalizations is of considerable help in coping with practical problems. It is encouraging to find a reflection of this in the increasing activity around corrosion on the part of research and technical personnel. There are, for example, very few among the major petroleum production laboratories that can not claim an active corrosion section.

The history of corrosion theory presents a general metamorphosis wherein the search for mechanisms was shifted from the area of chemical reactions to that of electrochemistry. In the absence of an unquestionable and universally applicable theory, there is a tendency among all of these ideas to persist regardless of more substantial developments. One of the first significant observations was made toward the end of the eighteenth century when it was discovered that in the corrosion of iron by water, the water becomes more alkaline. It was not until about 100 years later, however, that theory showed some degree of development. At this time the acid theory of corrosion was advanced. At first this theory postulated the presence of carbonic acid for ferrous corrosion but subsequent developments included other acids. One expression of this theory is given in the following chemical equations:

$$4Fe + 4H_2CO_3 \rightarrow 4FeCO_3 + 4H_2 \quad (1)$$

$$4FeCO_3 + O_2 + 10H_2O \rightarrow 4Fe(OH)_3 + 4H_2CO_3 \quad (2)$$

To include those instances where corrosion took place in the absence of oxygen, the following mechanism was offered:

$$4Fe + 4H_2CO_3 \rightarrow 4FeCO_3 + 4H_2 \quad (1)$$

$$4FeCO_3 + 10H_2O \rightarrow 4Fe(OH)_3 + 2H_2CO_3 + 2HCOOH \quad (3)$$

$$Fe + 2HCOOH \rightarrow Fe(CHO_2)_2 + H_2 \quad (4)$$

$$2Fe(CHO_2) + 2H_2 + 3H_2O \rightarrow 2Fe(OH)_3 + 3HCHO + HCOOH \quad (5)$$

At about the same time, some of

About the Author

DR. ALFRED CHATENEVER is currently directing the API's research project 47B as research engineer and associate professor of petroleum engineering at The University of Oklahoma at Norman. He received his B.S. degree in chemistry from New York City College in 1936, his master's degree at Columbia University in 1937 and his doctorate in physical chemistry at New York University in 1948. From 1938 until 1942 he was chief chemist and head of research and development for the Aquatic Chemical Laboratories at New York City, and the following year was senior chemist for the Matam Corporation at Long Island City. In 1944 he joined the Manhattan District Project in New York City as a research scientist and section leader, which position he held until 1946 when he again joined the Aquatic Chemical Laboratories as technical director. He spent one year as a private consultant and in 1949 became associated with the College of Engineering at The University of Oklahoma.

MULEHEAD. QUICKLY DETACHABLE. SLING LOAD EQUALISED.

SADDLE. NEEDLE BEARINGS, LATERAL AND LONGITUDINAL ADJUSTMENT TO ALIGN MULE-HEAD WITH POLISHED ROD.

EQUALISER. NEEDLE BEARINGS IN ADJUSTABLE SPHERICAL MOUNTING. QUICK RELEASE FROM WALKING BEAM AND EQUALISER BEAM.

CRANKPIN. LE GRAND PATENT. QUICK RELEASE FROM CRANK. HEAVY DUTY SELF-ALIGNING ROLLER BEARINGS. RUGGED CONSTRUCTION.

LEVER OPERATED BRAKE

PROVISION FOR EXTENDED BASE FOR PRIME MOVER. INCORPORATES REAR OPERATED BRAKE LEVER.

UNIVERSAL SLIDE RAILS

LE GRAND

Pumping Units

RUGGED CONSTRUCTION AND PRECISION BUILT THROUGHOUT.

Unit illustrated is the 25/72.C.C. Model with double helical double reduction gear box. 330,000 lbs. ins. Peak Torque. Polished Rod Load 25,000 lbs. Polished Rod Strokes. 24" 36" 48" 60" 72".

LE GRAND SUTCLIFF & GELL LTD

SOUTHALL, MIDDLESEX & ROCHESTER, KENT, ENGLAND

Telephones: Southall 2211 & Chatham 4626 Telegrams: Legrand, Southall Cables: Legrand, Southall Codes: A.B.C. 6th Edition

OILFIELD EQUIPMENT MANUFACTURERS & FOUNDERS

the interested investigators put their support behind the hydrogen peroxide theory of metallic corrosion. In this concept hydrogen peroxide is formed and becomes a strategic material in the corrosion process. The following is one of the suggested mechanisms:

$$2Fe + 4H_2O \rightarrow 2Fe(OH)_2 + 2H_2 \quad (6)$$
$$2H_2 + 2O_2 \rightarrow 2H_2O_2 \quad (7)$$
$$2Fe(OH)_2 + 2H_2O_2 \rightarrow Fe(OH)_3 + H_2O_2 \quad (8)$$
$$Fe + H_2O_2 \rightarrow Fe(OH)_2 \quad (9)$$

About 1910 activity had begun around ideas concerned with the electrochemical behavior of metals and continued to increase until what might be called the electrochemical theory of corrosion is today generally accepted. With beginnings in the Nernst concept of the single electrode potential, it has developed extensive ramifications to account for the many and varied corrosion phenomena. It takes from electrochemistry concepts such as spontaneously generated electromotive forces (E.M.F's), imposed electric currents, polarization, overpotential, etc., for purposes of mechanism in the corrosion of metals.

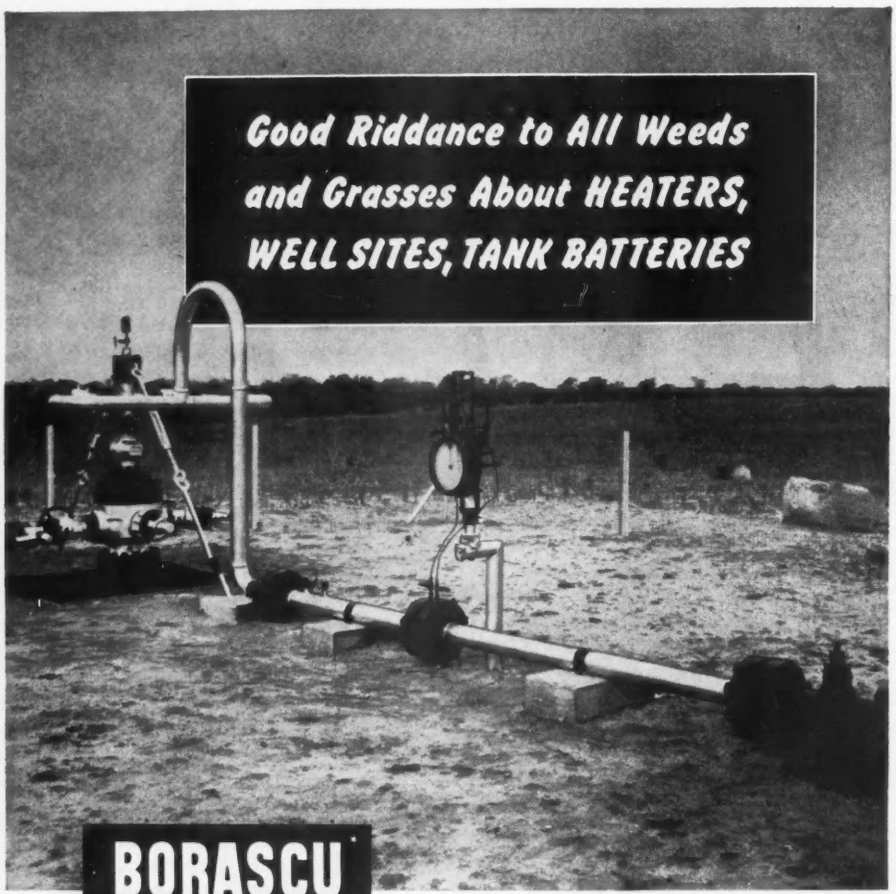
Consider the case of corrosion in a system containing two dissimilar metals in contact in a corroding liquid. It is well known that if an iron nipple were joined to a zinc or galvanized coupling in saline water, the zinc rather than the iron would corrode. On the other hand, if the iron nipple were joined to a copper coupling, it would be the iron and not the copper that would corrode. A ready analysis of these phenomena is found in the familiar electromotive series. This is based upon the concept that each metal has a characteristic tendency to send its ions into solution when surrounded by an aqueous medium. At the same time, it holds back within itself the electrons produced in the formation of the metallic ions from the metal atoms. The stronger the exhibition of this tendency, the less noble is the metal called.

If two metals were put into a common solution, each would probably manifest this tendency to a different degree. The more active or less noble of the two would send out ions to greater degree and gather electrons in stronger concentrations than would the more noble. Thus, if the two metals were connected externally by an electrical conductor to permit the flow of current, electrons would flow from the higher concentrations on the less noble metal to the lower concentrations on the more noble metal. This would permit the formation of more electrons on the less noble metal to replace those lost in the electrical transfer and additional metal would dissolve to form ions in solution and electrons on the metal for transport through the conductor. In this way a situation can arise where a metal can be sacrificially dissolved simply by being connected electrically to a more noble metal.

For most purposes, the more common metals can be listed on the basis of whether they are more or less noble. This listing is named the electromotive series. It is given with the more noble metals at the end in the following:

Potassium	Zinc	Hydrogen
Sodium	Chromium	Copper
Barium	Iron	Mercury
Calcium	Cadmium	Silver
Magnesium	Nickel	Platinum
Aluminum	Tin	Gold
Manganese	Lead	

Any metal upon being electrically connected to one after it in the above series in an aqueous medium will then tend to dissolve sacrificially. On



BORASCU
WEED KILLER

BORASCU* destroys weeds and grasses at a fractional cost of hoeing methods etc. Enjoy substantial savings by using BORASCU* about *your* tank batteries, well sites and heater units, just as many other petroleum producers do now. BORASCU* destroys most vegetation; prevents future growth for 12 to 24 months, or longer, when correctly used! Borascu* and Concentrated Borascu* are applied dry . . . with spray equipment, use our new, *non fire-hazardous* Polybor-Chlorate-88.

*Reg. U.S. Pat. Off.

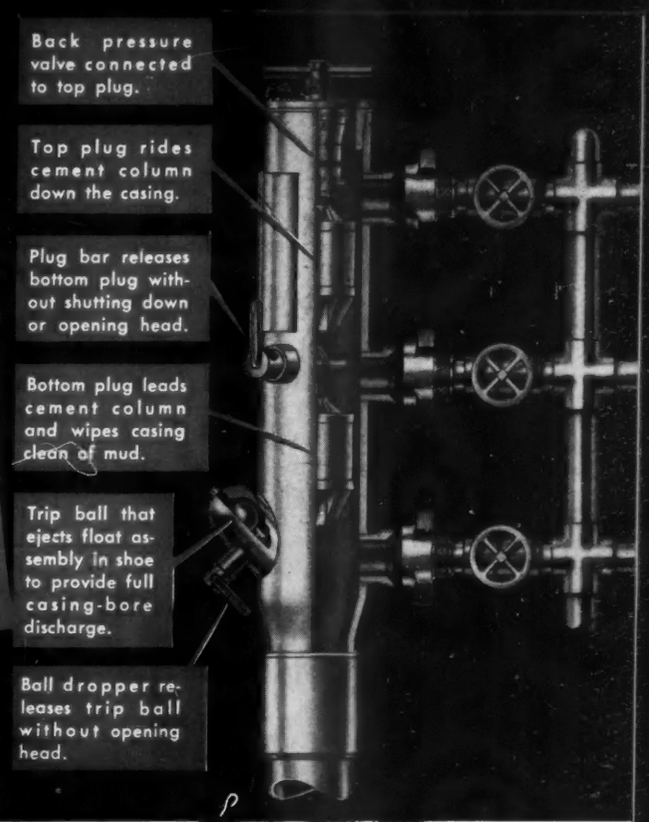
NONCORROSIVE* • NONPOISONOUS • NONFLAMMABLE • NONSELECTIVE

*To Ferrous Metals

PACIFIC COAST BORAX CO.
DIVISION OF BORAX CONSOLIDATED, LIMITED
510 WEST SIXTH STREET • LOS ANGELES 14, CALIFORNIA

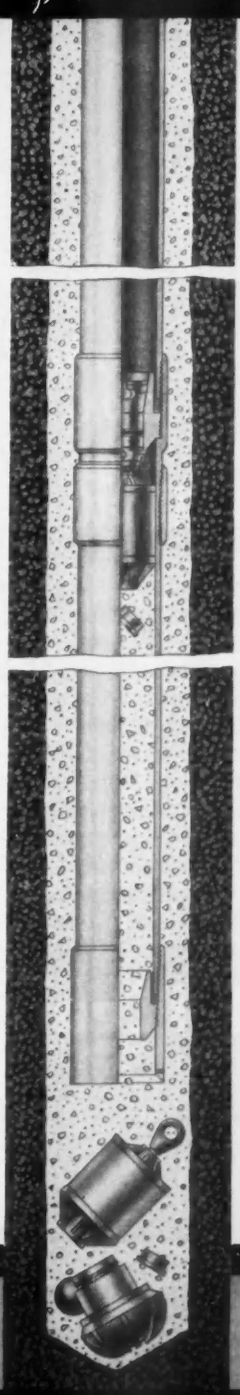
Weed Control Dept. Representatives located in: CHICAGO • NEW YORK CITY • NEW ORLEANS SEATTLE • PORTLAND, ORE. • CLEVELAND, OHIO • AUBURN, ALA. • KANSAS CITY, MISSOURI HOUSTON, TEX. • FT. WORTH, TEX. • SIOUX CITY, IOWA • BOZEMAN, MONT. • MINNEAPOLIS, MINN. • SAN FRANCISCO • Home Office: 510 W. SIXTH STREET, LOS ANGELES 14, CALIFORNIA

From HEAD to SHOE


Back pressure valve connected to top plug.
Top plug rides cement column down the casing.
Plug bar releases bottom plug without shutting down or opening head.
Bottom plug leads cement column and wipes casing clean of mud.
Trip ball that ejects float assembly in shoe to provide full casing-bore discharge.
Ball dropper releases trip ball without opening head.

RECTOR FULBORE CEMENTING METHOD

prevents contamination of cement



Every operator knows that voids caused by air pockets in the cementing string or soft spots due to contamination are the perfect set-up for future trouble. Prevention of these weaknesses is the basis of "Fulbore" cementing superiority . . . the assurance of a master cementing job, everytime.

The "Fulbore" multiple inlet head provides a closed circuit from beginning to end of cementing operations. The two plugs, made up in the head before it is connected to the casing string, are released mechanically without downtime. the plugs completely and effectively segregate the cement from the time it enters the head until discharged at the shoe. There is no possibility of contamination or the formation of air pockets.

Extreme simplicity is another advantage of "Fulbore" cementing. There are no discs to break . . . no small orifices through which the cement must be pumped. Traveling ahead of the cement, the bottom plug is pumped out of the casing through the float shoe from which the float assembly has been ejected after cementing string has been floated into position. This provides full casing discharge capacity . . . reduces the load on the pumps . . . permits greater volume to be circulated with same pump discharge pressure . . . results in higher velocity in space between casing and bottom of hole.

Every phase of "Fulbore" cementing is planned to make every job a master cementing job. Ask your Rector Representative or authorized supply store for full information about "Fulbore" Cementing and equipment.

RECTOR WELL EQUIPMENT COMPANY INC

★ MAKING THE OIL INDUSTRY SAFER ★

1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

REPRESENTATIVES IN ALL ACTIVE FIELDS

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

RECTORHEAD RECTOR FULBORE CEMENTING METHOD RECTORSEAL

joining an iron nipple to a zinc coupling in an aqueous medium, the less noble zinc would dissolve rather than the iron. On the other hand, if the iron nipple were joined to a coupling of the more noble copper, the iron would then dissolve.

The tendency to produce electric currents arises from systems other than of the bimetallic type. If two pieces of the same metal were placed into different solutions that were connected electrically but had different concentrations of the ions of the metal, each piece would gather electrons to a different extent. The one in the less concentrated solution would build up stronger electronic concentrations than the other. Thus if the two were connected by a wire, electrons would flow from the piece in the less concentrated solution to the other and the former would dissolve rather than the latter.

It has been shown that an electric current can likewise be generated simply by aerating the solution around the two pieces of similar metal to a different degree producing different oxygen concentrations in the solutions. In this case, the greater the oxygen concentration, the more noble the metal.

This phenomenon offers an interesting explanation for pitting by corrosion. Consider a particle of dirt resting on a metal surface in an aqueous solution as diagrammed in Figure 1. At the points of contact, the particle and metal meet each other to form a wedge. If the solution were exposed to an atmospehre containing oxygen, it would dissolve the oxygen. The oxygen, however, might not be uniformly distributed. It might be more strongly concentrated in the open spaces than in the tight crannies into which it could not get very easily. Similarly, in the wedge between the particle and the metal a stronger oxygen concentration might arise in the base than in the apex. This would result in a situation in which a metal would be differently aerated at two different points causing a localized solution of the metal at the point of lesser oxygen concentration resulting in a small pit at the point of contact with the particle.

This small pit in turn offers a situation that might create different oxygen concentrations. It would be expected that there would be a smaller concentration at the bottom of the pit than in the opening at the surface of the metal. Consequently, the metal would dissolve at the bottom of the pit rather than at the top. This process would continue until a pit developed as indicated by the broken line in the diagram in Figure 2 would go through the metal.

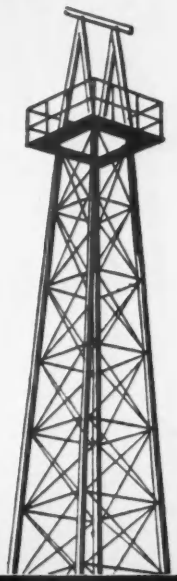
Phenomena such as these find a simple analysis on the basis of the electrochemical theory whereas there is no ready explanation forthcoming from the chemical theories. This logically raises a practical question: Can we explain all corrosion phenomena on the basis of existing theory? The answer, as every field engineer knows, is "no."

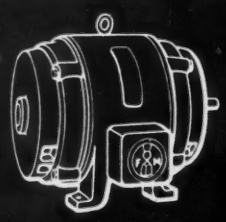
The reason for the negative answer seems to be two-fold. In the first place, almost all corrosion phenomena are complicated by the influence of many factors. Very often these factors are of such numbers or unknown characteristics as to render the phenomenon incapable of analysis for the application of the theory. Secondly, the science of corrosion has not yet reached the point where it has exhausted all of the theoretical possibilities; and it might well be expected that there are significant developments yet to come. In the absence of such knowledge, some corrosion problems will go begging for a solution until further research uncovers the necessary pertinent information.

★ For working pressures from 1500 to 3000 lbs.
★ All parts interchangeable
★ Bean is quickly and easily replaced
★ Easily converted to positive choke
O-C-T THREADED ADJUSTABLE CHOKES GIVE YOU
Four Star Flexibility
The O-C-T Type "N" Adjustable Choke has earned its reputation as the most popular choke in the field by outstanding, dependable performance. In combination with O-C-T Flow Tees, this choke can be used to make proration tests by simply backing off the yoke nut and inserting the proper size O-C-T FC-140 positive bean or O-C-T FC-141 insert cage bean. Ask your O-C-T representative or write for complete mechanical details on the O-C-T Choke that gives you four star flexibility. Available through your supply store.
Oil Center Tool Co.
P. O. Box 3091, Houston, Texas
O-C-T HAS PIONEERED HIGH PRESSURE CONTROLS

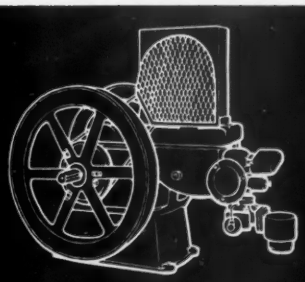
For More in Oil Field Equipment

it's FAIRBANKS-MORSE

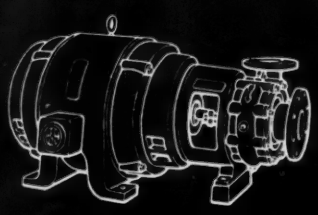




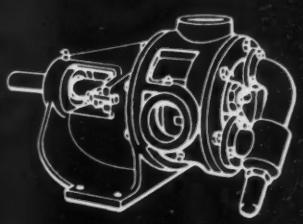
Electric Motors



ZC Engines



Builtogether Pumps

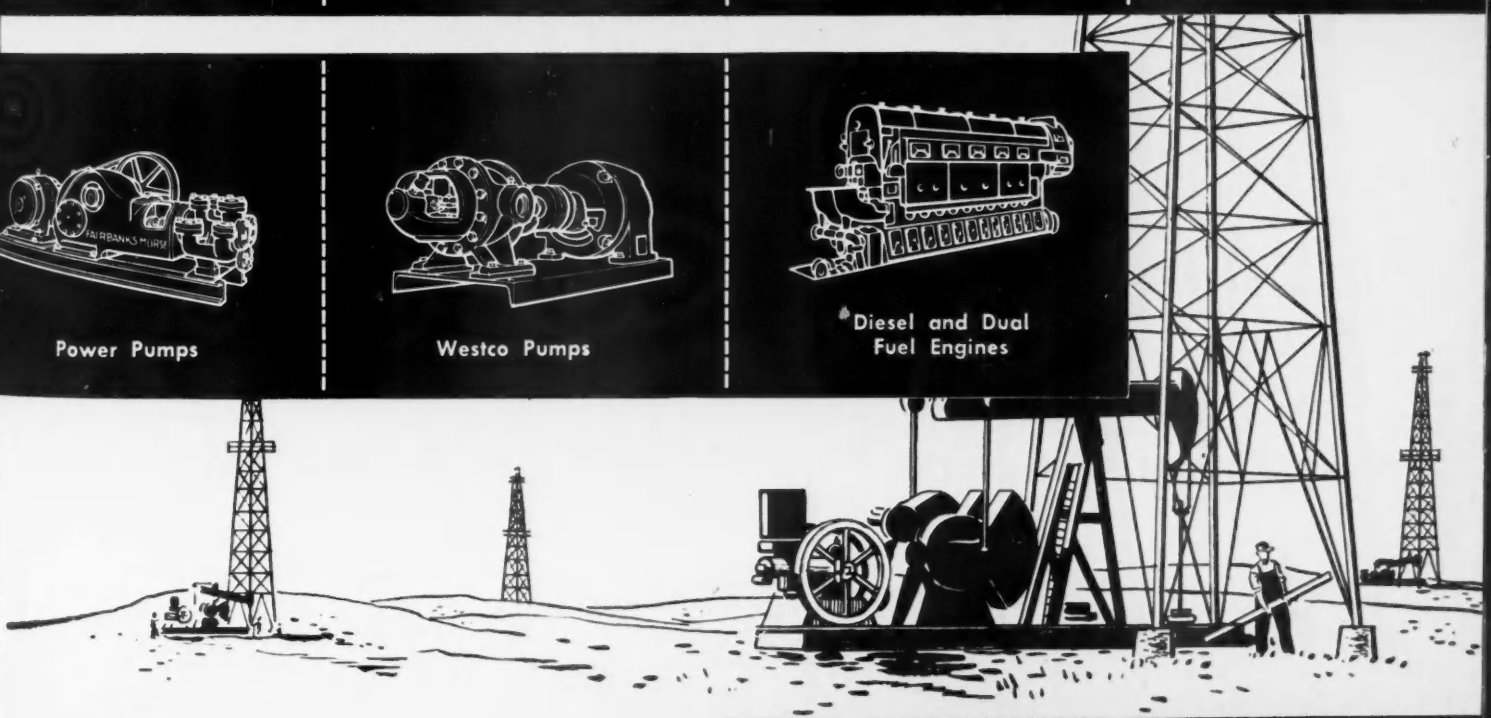


Rotary Pumps

Power Pumps

Westco Pumps

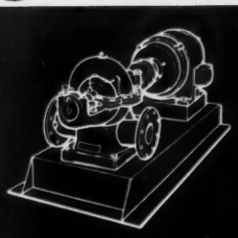
Diesel and Dual Fuel Engines



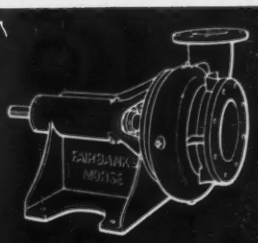
FAIRBANKS-MORSE,

a name worth remembering

OIL FIELD EQUIPMENT • PUMPS • SCALES • ELECTRIC MOTORS
LIGHT PLANTS • DIESEL, DUAL FUEL AND GASOLINE ENGINES
GENERATORS • MAGNETOS



Single and Two-Stage Centrifugal Pumps



Side-Suction Centrifugal. Pumps

How to do it! PRODUCTION HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

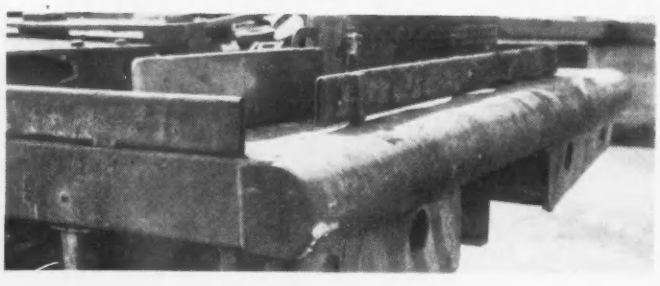
HOW TO—Clean Out Flow Lines with Portable Heater

A shopmade portable heater has enabled one operator to heat oil coming from the flow line to remove paraffin or to improve treating for emulsions. This trailer-mounted heater can be transported to the well and connected into the flow wing of the christmas tree so that production need be interrupted only a short period in making the connection.

The portable heater shown is an indirect heater, utilizing hot water as the heat transfer medium. The pressure vessel has been thoroughly insulated to increase its efficiency, and mounted on a heavy-duty trailer to increase its portability. One of the unique features of this heater is the manner in which fuel is supplied to the burners. A reel was mounted to the side of the vessel with brackets and equipped with swivel joints so that a long hose could be attached to supply gas to the unit. The end of the hose could be attached to the nearest field gas system outlet, and regulators at the burners lowered the pressure to operating limits. It was a simple matter to connect up the fuel line, since no piping was involved. When the job was completed, the hose could be reeled up quickly.

To provide flow through the heater, two lines were equipped with swivel joints. These lines had standard two-inch connections on them for flowing pressures. Flexibility in the lines provided by the swivel joints facilitated hooking up the heater to the well. Pressure gauges were installed on the lines at the end of the heater so that the operator could determine when the line was cleaned by a change in flowing pressure. Oil flowed from the wellhead through the line into the heater where its temperature was substantially increased, and discharged through the second line into the normal flow line on the lease. Such a heater as described has its advantages since it can be used on any of the wells in this field without disrupting very long the flow of oil into the tank battery.

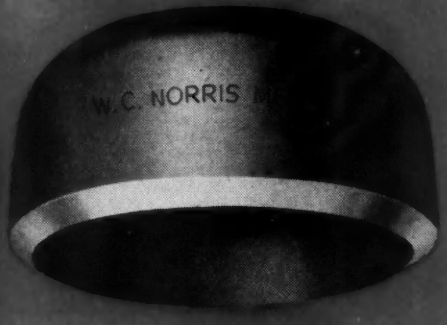
HOW TO—Construct an Improved Guard for Truck Bed

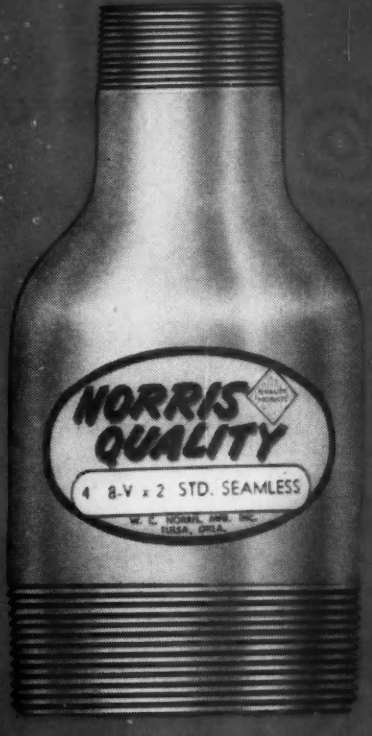


Because of the nature of the equipment generally hauled and the type of service to which it is subjected, the production service truck, generally a flat bed unit, is equipped with a low but sturdy rail. Such rails usually consist of lengths of two- or three-inch pipe or structural steel. One operator finds it desirable to make the railings on such trucks out of pieces of two-inch pipe that have been flattened in the manner illustrated. This type of guard rail is inexpensive, provides a slightly higher rail for a given size of pipe and makes possible a slight increase in the useful working space of the truck bed. Small stakes are welded to the rail sections. When completed, the rails form sturdy, practically indestructible units which will stand the rough handling and abuse to which they normally are subjected as heavy equipment is loaded and unloaded.

PIONEERS

NORRIS





W.C. NORRIS, MANUFACTURER, INC.

TULSA, OKLAHOMA

WEST COAST DISTRIBUTORS:
REPUBLIC SUPPLY COMPANY OF CALIFORNIA,
Los Angeles

QUALITY
Since NORRIS 1882
PRODUCTS

BRANCHES:
HOUSTON, KILGORE, ODESSA, TEXAS;
SALEM, ILLINOIS; CASPER, WYOMING
EXPORT: 30 ROCKEFELLER PLAZA, NEW YORK CITY

PENBERTHY
Liquid Level GAGES

REFLEX

Reflex type complete with gage valves. Liquid shows black—empty space shows white. Liquid level is always unmistakable.

TRANSPARENT

Transparent type complete with gage valves. Used where through vision is desired under high pressures and/or temperatures.

DROP FORGED STEEL

Tubular glass type, Chrome-Moly temperature resisting steel body, stainless steel trim, regrinding removable seats.

ALL IRON

Tubular glass type, extra heavy body of special high strength alloy iron, shanks alloy steel, trim stainless steel, valves self-cleaning.

There is a Penberthy Gage of superior quality for every liquid level gage requirement. Gages are fabricated to customer's specifications from special alloys to meet unusual corrosive and temperature conditions. All Penberthy Gages conform with API-ASME requirements.

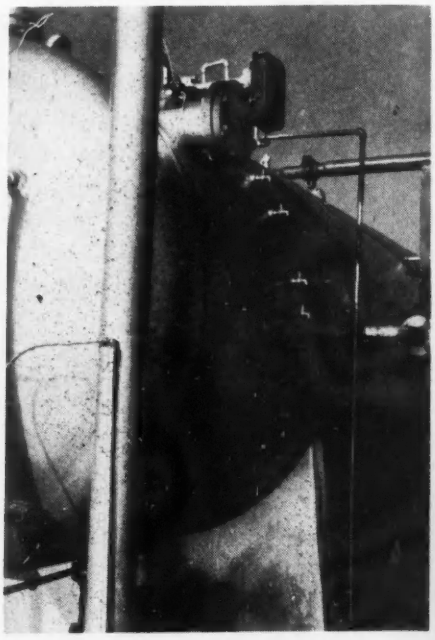
3277-B

PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant — Windsor, Ontario

HOW TO—*Take Sample at Separator*

Large volume horizontal units serving as oil and gas separators as well as oil and water separators have been used effectively on many leases adaptable to this type equipment. In some instances, the operator desires to know the bottom sediment and water content of fluids in the liquid trap of the separator as well as to keep a check on the fluid levels in the vessel. A practical means of taking liquid samples from such a horizontal separator is shown. Stop cocks were screwed into short nipples welded to the circumference of the cylindrical vessel at vertical intervals of about four inches. Of course, those cocks placed below and above the center line of the vessel were progressively further apart than four inches.

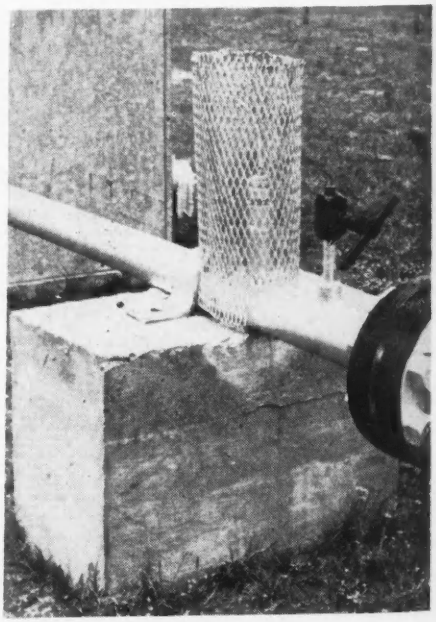
Such an installation enabled the pumper to take liquid samples from the bottom of the fluid chamber and determine the bottom sediment and water content of each sample. He could also check the efficiency of the water separation as well as determine the interface between the gas and oil. This sampling means was simple and provided a positive check on performance and fluid characteristics.



HOW TO—*Guard Temperature Tube*

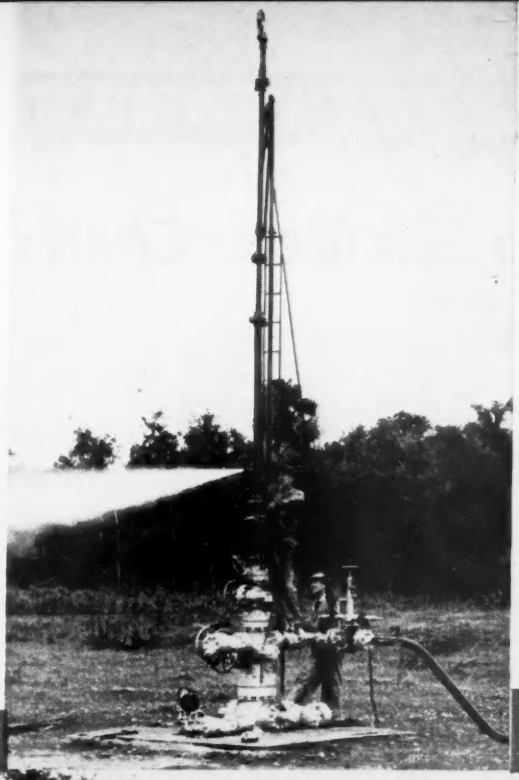
In metering the volume of gas injected in a pressure maintenance project, it is necessary to make a temperature correction since the gas being injected has been compressed and the temperature has taken a corresponding increase with pressure. A temperature well was placed in the line about ten feet upstream of the orifice plate to hold the temperature element. This well was supported by a short nipple welded to the line at right angles. A series of bushings packed the temperature element tube which was connected to the temperature recording mechanism of the chart.

One of the hazards involved in piping the temperature variations through such a small tube is that of breaking the tube between the element and the recording meter unless the tube is adequately protected. In such an installation as that shown, the tube must come out of the temperature well in line with the tee housing it. The tube then takes a complete turn and runs down to the gas line where it follows the line into the meter house. To protect the delicate tubing from roaming stock or accidental injury from roustabout crews working on the meter setting, a small housing was made from expanded metal as shown. It was spot welded to form a cylinder and then cut at the bottom to fit over the gas line where it was wrapped underneath to serve as a hold down or support.



Tuboscope

SERVICES help where shortages hit hardest!



Tubing Caliper Surveys and other Wire Line Services

Sonoscope Above ground pipe Tuboscope Inspection

Tuboscope Services offer a direct means of attacking and reducing the high costs of drilling and producing: ▶Protecting your drill pipe and casing with TUBE-TECTORS, the laminated drill pipe-casing rubber protectors with the most effective gripping strength; ▶Inspecting your drill pipe, tubing, and casing with Tuboscope and Sonoscope, the only scientifically accurate methods of non-destructive testing in the field. Frequent inspection assures the maximum safe life from each length of pipe, prevents discarding pipe still useable. ▶Tubing Caliper Surveys, on wells under pressure, locate, measure, and record irregularities on the inside surface of tubing, show exactly which lengths are good, which should be discarded. Tuboscope helps where shortages hit hardest. Write or call for more information on reducing your costs and saving hard-to-get pipe.

**The Names SONOSCOPE and TUBOSCOPE are registered in the U. S. Patent Office.*

Tube-Tectors installed directly from Applicator to pipe on rig floor.

Tuboscope
OILFIELD TUBULAR INSPECTION

TUBOSCOPE COMPANY
Division of
TUBULAR SERVICE & ENGINEERING COMPANY
P.O. Box 8295 Houston 4, Texas

Wherever
POWER IS GENERATED
There Is Definite Need
for
SAND-BANUM
Pure Colloidal Concentrate
SAVES
Power Plant Dollars
through Safe and Certain
Removal and Prevention
of Boiler Scale

Use Ounces Only
Once a Week

•

For ALL Radiator
Cooling Systems
SAND-BANUM SPECIAL
in Convenient Tablet Form
Removes and Prevents Rust
and Scale.

Buy Today and Learn
How and Why Sand-Banum
Saves and Serves You
Better.

•

Stocked By
Leading Supply Houses

AMERICAN SAND-BANUM CO.
Established 1926
9 Rockefeller Plaza
New York 20, N.Y.

HOW TO—*Keep Gas Meter Charts Dry*

One of the perennial headaches to the meter department can be overcome by a simple meter chart carrying case. Dampness and rain can easily ruin the average clean meter chart to the extent that it is difficult to make an accurate integration of the chart for gas measurement. A primary problem is keeping the charts, once removed from the meters, in a dry condition. This is a difficult situation for field men who have other responsibilities.

A circular galvanized sheet metal case offers the solution to this problem. Illustrated is a suitable design that has proven not only convenient, but capable of preserving the gas measurement meter charts in usable condition. The case is about one inch larger in diameter than the meter chart used in the field. Its thickness is three inches to provide adequate space for the number of charts expected to be picked up during the pumper's rounds. As shown, the hinged cover has brass hinges soldered at the breaking point about one

For **WEATHERPROOF** Oil Field Power
STANDARDIZE ON
WISCONSIN ENGINES

Here are good examples of dependable oil field power units at work! These pumps are powered by compact, Wisconsin Heavy-Duty Air-Cooled Engines. Each works in an isolated area, with a minimum of servicing.

Just as important as this advantage is the fact that Wisconsin Engines work efficiently during the hottest summer weather or the coldest day of winter, through rain or snow. Wisconsin Engines are weatherproof and practically fool-proof! Such features as tapered roller bearings at both ends of the crankshaft, fool-proof, all-weather *air-cooling*, and heavy-duty construction throughout are the reasons why Wisconsin Engines handle the job . . . the reasons why over 1,500,000 have been sold as independent power units and power components on a great variety of original equipment, representing a record total of over 18,000,000 available hp.

4-cycle single-cylinder, 2-cylinder, and V-type 4-cylinder models, 3 to 30 hp.

WISCONSIN MOTOR
Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

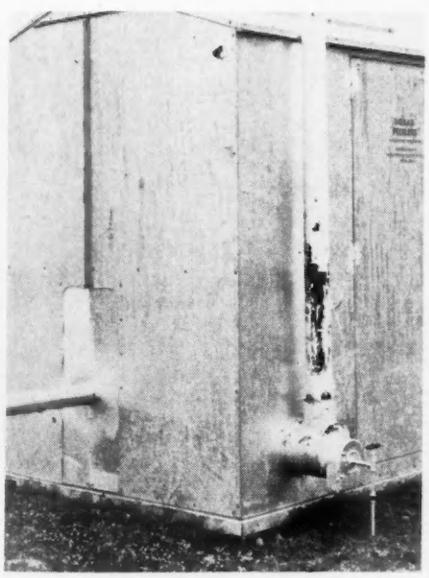
WRITE TO HARLEY SALES CO.
619 S. MAIN STREET, TULSA, OKLAHOMA
M & M BUILDING, HOUSTON, TEXAS
505 SOUTH MAIN ST., WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

inch below center of the circular case. The edge lip extends over the solid back side so that rain can be expelled. A large circular blotter is attached to this back side so that when a chart is inserted into the case, the pumper can press the chart to the blotter to remove any excess ink that might remain on it.

Just below the hinge line on the cover, a small metal box is soldered to the case as shown. Wedged in this box are bottles of green and red ink for refilling the meter pens each time a chart is removed. A leather key holder attached to this box holds the meter clock winding key. Thus, instead of locating ink supply and clock keys at each meter, these items are carried conveniently by the pumper when he services each meter station.

HOW TO—

Heat Air Inside of Gas Meter Housing



Because of the drop in temperature across the orifice plate of an orifice meter used in gas measurement, there are conditions of the gas where hydrates will form if the temperature on the downstream side of the meter drops below the dew point of the gas. This problem of hydrate formation is particularly troublesome during the winter months, but can be serious even in the spring or fall. Experience has shown that the practice of housing the meters and warming the air inside has eliminated much of the trouble encountered previously from plugged up orifice plates. Heating the inside of the meter

CRALL SPIRAL SCRAPERS

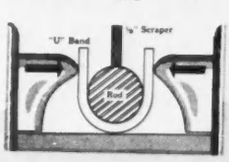
Pay for themselves!

● ELIMINATE PARAFFIN
● SAVE DOWN TIME
● SAVES WORK-OVER STRIPPING JOBS

CRALL Spiral Paraffin Scrapers pay for themselves. The original small cost is the ONLY cost. They're the one SURE way to eliminate paraffin in the tubing of pumping wells. They will not harm sucker rods or well tubing and will not slip on sucker rods.

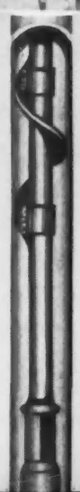
HERE'S HOW THEY WORK

1. Scrapers alternate — one right, one left — eliminating tendency of rod to unscrew.
2. Scrapers are attached to rods at our various fabricating plants, and stocked at supply stores.



Cross section showing "U" band being die-formed around rod to the scraper blades.

Cross section showing band held under pressure around rod while ends of bands are shrink-grip attached to scraper blades.



Order your CRALL Spiral Scrapered rods from your supply store or wire, write or phone . . .

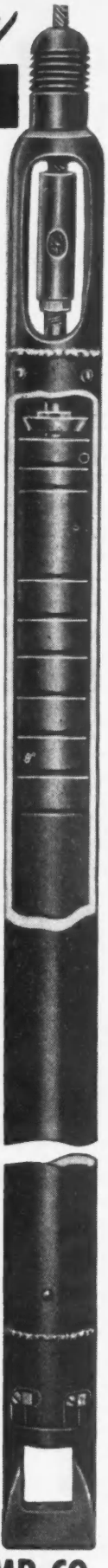
PETROLEUM SPECIALTY CO.

P. O. BOX 1640 PAMPA, TEXAS

Manufacturing, Fabricating Plants and Sales Offices

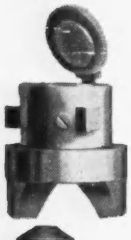
Pampa, Sundown and Odessa, Texas — Casper, Wyoming — Oklahoma City and Chickasha, Okla.

Miller SAND PUMPS



In every major producing area where sand or sediment is a problem, you'll find Miller Sand Pumps and Bailers are standard . . . the leaders in clean-out equipment. For 26 years Miller has held this leadership, with continuous improvements and faithful service.

The Miller Sand Pump is made in regular and heavy duty types in sizes listed below. Lug type, chisel, sand and bailer bottoms are easily interchanged.



SAND PUMP and BAILER SIZES:

Outside Diameters

2½"
3"
3½"
4¼"
5"
5½"
7"

Lengths

20 feet
25 feet
30 feet

Special Sizes and Lengths Made to Order!

Write for new descriptive price list on Miller Sand Pumps and Bailers. See Composite Catalogue Page 3305 for details.

MILLER SAND PUMP CO.

1524 S. E. 29 St. . . . . Box 4516
OKLAHOMA CITY 9, OKLAHOMA

EXPORT OFFICE:
30 Rockefeller Plaza-New York 20, N.Y.

house also insures smooth performance of the meters, so long as the temperature does not become too hot.

A prefabricated metal housing was placed over this meter station which included two orifice meters. The enclosure rested on a concrete slab foundation. Metal doors on either side of the house allow entrance on both sides of the enclosed meter setting.

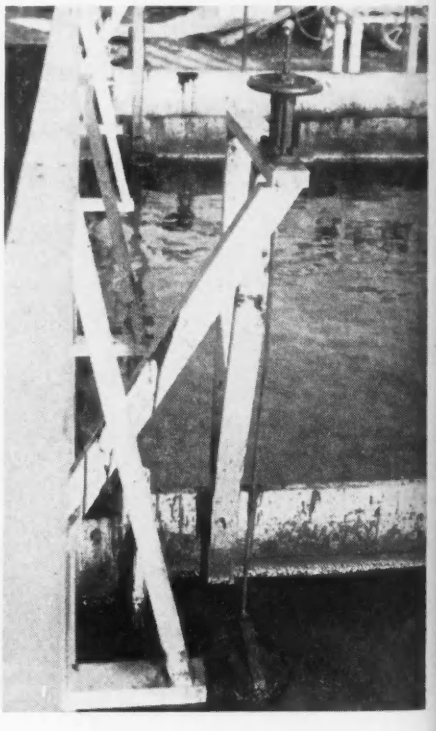
Heat in the metal enclosure was provided by a double-leg pipe heater fired by field gas. A section of eight-inch pipe about six feet long was sealed at one end. At the opposite end, a shorter section of three-inch pipe was inserted inside the eight-inch casing so that the smaller pipe rested on bottom of the larger pipe. The annulus was welded closed, and a stack opening was cut in the top of the larger pipe as shown. This telescoping heating unit was inserted in the meter house so that only one end extended outside. Through this end was fed the fuel, and the gases were exhausted through a six-inch stack about ten feet long that created a draft through the heating element. Gas was controlled by a half-inch needle valve on the fuel line which extended inside the three-inch pipe about six inches. An opening at the bottom of this section made it possible to light the heater and to control the flame. The flame was forced to travel the length of the three-inch pipe, then circulate back through the eight-inch pipe before leaving the stack.

HOW TO—*Adjust Skim Pit Discharge*

Level of the oil discharge line of a skimming pit can be easily adjusted by adapting a discarded gate valve stem and head. It is necessary in water disposal systems that all oil be removed from the water, which is later treated and injected back into disposal wells. To provide a clean separation of oil from water produced, normal practice is to flow the water into a skimming pit where there is ample surface area to permit the oil to rise to the surface of the water.

Such skimming pits are divided by baffle boards set so that the bottom edge extends down below the water-oil contact of the liquids in the pit. The flow of water into and out of the pit is such that the baffle traps the oil on one side of the pit and allows the clear water to flow under the baffle into the other side of the pit where it is drained off and further treated prior to injecting into the disposal formations.

One of the problems attendant to skimming pits is that of taking off this thin top layer of oil without removing any of the water lying just beneath it. So long as the level of the water in the pit is accurately regulated, a skimming device such as that shown can be installed with effective results. In the skimmer illustrated, a piece of large-diameter casing was coned down and attached to a flexible hose which leads to an oil storage pit. The upper edge of the funnel was serrated and equipped with a strap steel bracket which is attached to a supporting rod. This rod extends up to a convenient working height where the level



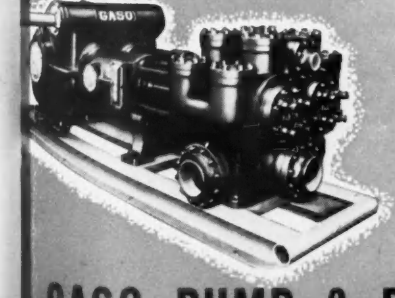
of the skimmer can be carefully adjusted. The upper end of the rod was welded to the end of a discarded gate valve stem which is a part of the discarded head of the gate valve. This head is mounted on a wooden platform as shown and by merely rotating the valve wheel, the level of the skimmer can be adjusted to any desired height to take off only oil from the pit. The number of these skimmers required depend upon the volume of water handled and the oil content of that water.

WORLD OIL

PIPE LINE SECTION

DONALD M. TAYLOR, SECTION EDITOR

All the miles of 12 years' driving!

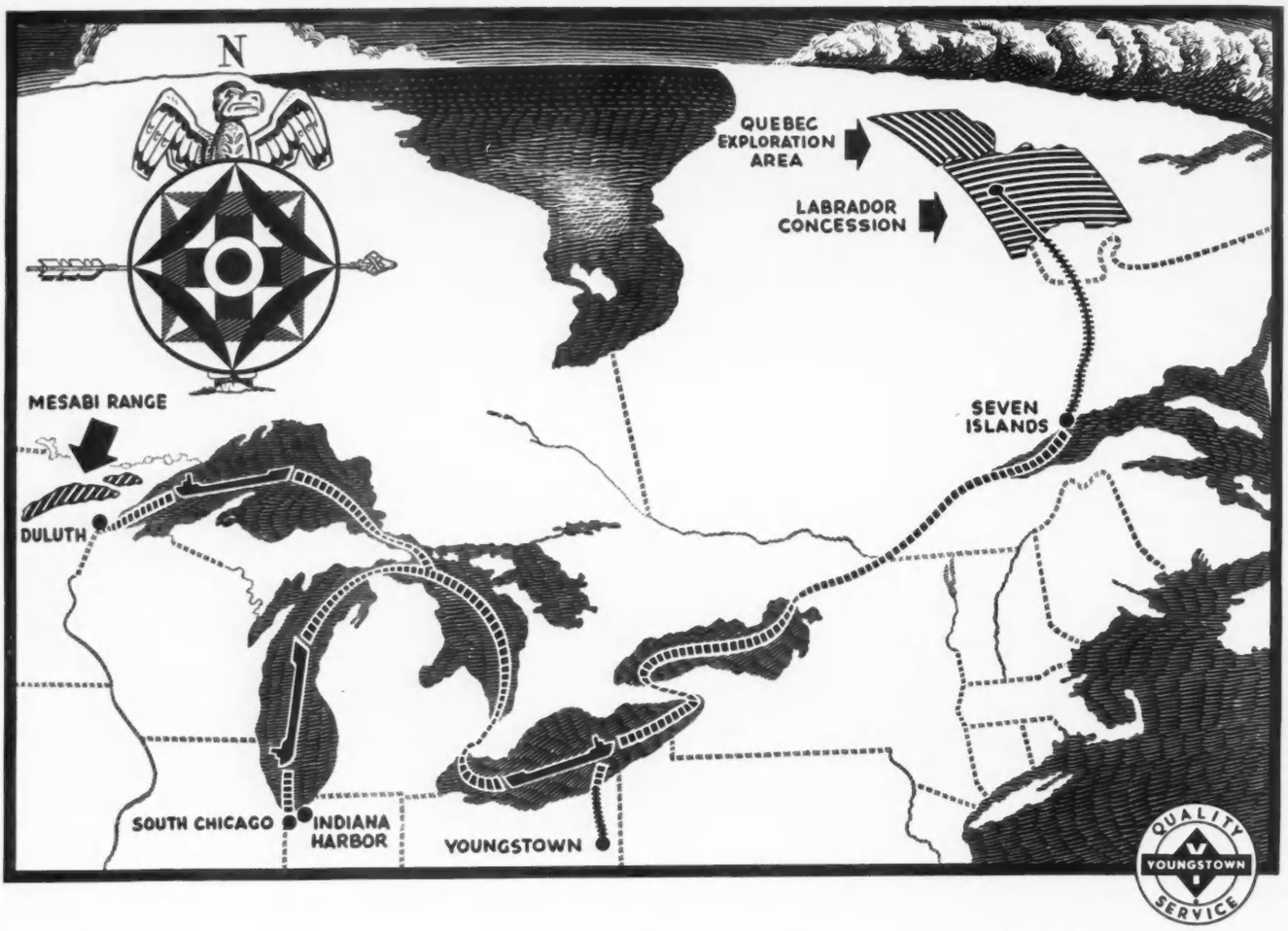


The average motorist, driving 12,000 miles a year, would have to drive more than 12 years to equal the pipe line mileage which today helps to bring petroleum products to the people of America and keep down its cost. The installation and operation of so vast a transportation system is a monumental achievement in which we are proud to have a part as the industry's favorite source of portable pumping units.

ADAPTABLE GASO PUMPS

GASO PUMP & BURNER MFG. CO. 902 EAST FIRST ST., TULSA, OKLA.
EXPORT OFFICE: 149 BROADWAY, NEW YORK

Shreveport: W. L. SOMNER CO., 419 Lake Street • Los Angeles: 2529 Chambers St., Vernon • Western Canada: Lufkin Machine Co., Ltd., Edmonton, Alberta



Mister, can you spare Half a Billion Dollars?

ONE half a billion dollars may seem like pin money compared to the sums mentioned for our national finances.

But it is more than three dollars for each man, woman and child in the United States. It is more than the entire steel industry earned in the "dreadful decade" from 1930 to 1939. It's more than America spent to win two wars--the War of 1812 and the Mexican War, combined.

Approximately one half a billion dollars is the estimated sum that a group of steel and mining companies, one of which is The Youngstown Sheet and Tube Company, is investing to guarantee future iron ore supplies for America. In the Mesabi iron range of Minnesota, development projects are under way which will produce millions of tons of iron concentrates from taconite. In Labrador and Quebec, a vast deposit of high grade ore is being developed. Plans include building a 360-mile railroad into the wilderness to ore docks on the St. Lawrence River.

Where does this money come from? From an unnoticed addition to our national debt? From "extra nickels" tucked away in the Federal budget? From more taxes levied on every citizen's income? *Certainly not!* Development of these ore reserves will be financed by each participating Company asking its shareholders to share in its tremendous cost.

America, in peace or in war, is served--now --and for generations to come. This is free enterprise. This is the system that created America from a wilderness and is the only sure way to keep it vigorous and strong.

Scrap Metal is Critical Again

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio

Export Offices--500 Fifth Avenue, New York

MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

Submerged Arc Unit Welds Pipe Line On Right-of-Way

By C. A. RENTON

Engineer, O. R. Smith Company
Fort Worth

This new portable submerged arc welding unit, mounted on a side boom tractor, can weld any place tractors can operate.

A NEW portable submerged arc welding machine has been making as many as 85 high-quality, 26-inch pipe welds per ten-hour day, operating down the right-of-way, during recent weeks on a pipe line being constructed by E. J. Mahoney Contracting Company for Trunkline Gas Company between Flora and Joppa, Ill.

This equipment is an adaptation of the factory submerged arc process to field conditions. For use down the right-of-way, it is mounted on a side-boom tractor in such a manner that high quality welds can be made any place tractors are able to operate. The same high quality weld is produced whether the machine is operating on the slope of a hill, in mud or on level terrain.

Prior to this development, the use of submerged arc welding machines was limited to double-jointing operations in the pipe yard, where two single joints were welded together before being transported to the right-of-way. This machine, mounted on a tractor, is used on the line to weld 2-3- and 4-joint sections of pipe, the number in each section being limited only by contours of the ground and capacity of available construction equipment.

Basically, the unit consists of a welding head on a four-wheel carriage which rides on top of the pipe; an endless chain pipe roller powered by an electric motor; a flux feeding assembly; and a conventional D.C. welding machine.

The welding head carriage and main frame have several self-adjusting features which permit accurate welding even though the two joints of pipe are not on level ground. Two arms on the carriage are flexibly attached to the main frame, providing proper support for the carriage when it is rolling on the pipe or in a raised position. The main frame has a sliding adjustment on two tubular arms to compensate for varying distances between the tractor and pipe. These slide arms are attached to the tractor at a single fulcrum point by means of a ball joint.

Inside the main frame an electric motor with speed reducer provides the drive for a roller chain which encircles the pipe and permits it to be turned at proper speed for welding, which may vary from 18 to 56 inches per minute. Tension on the roller chain is maintained by means of a hydraulic cylinder arrangement operated by a small hand pump and controlled by a quick release valve.

The whole unit is suspended from the sideboom of a tractor and balanced for ease of handling. A flux box suspended from the boom has a flexible hose and check valve through which the flux is gravity fed into the hopper on the welding head.

The 600-ampere welding machine supplies power for welding, and the electrode feed mechanism is operated from the field exciter. An auxiliary power unit supplies current for driving the pipe rotating mechanism. Both these units are mounted on the side-boom tractor.

The correct amount of rod for welding is unspooled by the feed mechanism and controlled in proportion to the welding amperage being used. The rod is correctly positioned by a guide roller which runs in the bevel between the two joints of pipe during rotation, but when a hand stringer bead is used, the operator guides the electrode in the bevel by means of an indicating pointer.

The procedure for making a weld is to set a length of pipe by means of a sideboom tractor onto two dollies resting on skids on the ground. An internal lineup clamp is then inserted into the pipe, and the next joint is

ADAPTATION OF the submerged arc welding process to down the right-of-way pipe line welding is one of the most important developments in the pipe line construction industry in several years. A new light, portable welding unit making use of this process, which is commonly used in the manufacture of pipe, was mounted on a tractor and used to weld 26-inch pipe into 2, 3 and 4-joint sections. Tests proved the welds equal in quality to the longitudinal pipe welds made by the same process at the pipe mill.

The pipe is strung and placed on dollies, awaiting the submerged arc welding machine that will weld it into multiple joint sections.

During the actual welding, the machine is operated by four men: a welder, a welder-helper, a tractor operator and a utility man.

lined up with the first one and lowered onto a single dolly placed in the center of the joint. The tractor with the welding unit is then moved into position and the roller chain is fastened around the pipe near the bevel between the two joints. The welding head is quickly lowered onto the pipe by turning a crank on the side of the frame, and two passes of submerged arc welding are then made in about 4½ minutes. Under normal conditions, the total time taken to move the welding unit from one joint to the next and to set the welding head in position is approximately 1½ minutes. This makes the complete time cycle for each weld on 26-inch diameter pipe about six minutes, with a production rate of 85 to 100 welds per ten-hour day operating under normal conditions down the right-of-way.

The actual welding operation is simplified by several automatic and self-adjusting features of the equipment. Height of the weld above the surface of the pipe, the width of the weld and penetration on the inside of the pipe can be controlled by various combinations of adjustments, which include the regulation of welding speed, amperage, voltage and the offset of the electrode from the verticle axis of the pipe.

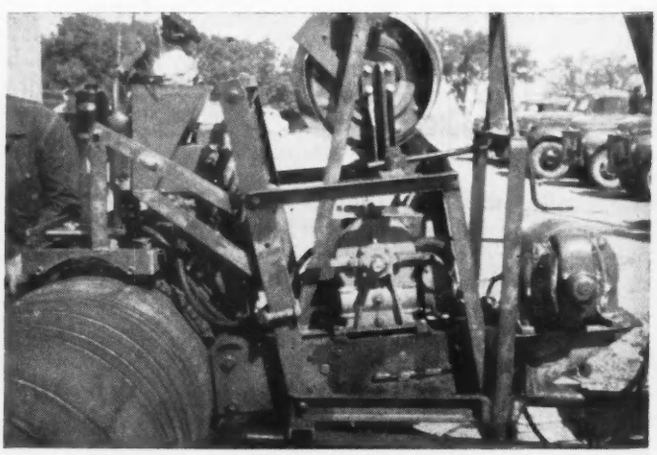
Welds are usually completed in two passes by this process. This is illustrated by Figure 6, which shows a micro-etched specimen from a typical weld. It can be seen that the first pass almost fills the bevel, while the second pass ties in the two joints. The area of penetration by the second pass upon the first is clearly brought out by etching. The heat generated by the second pass is retained in the weld by a thick outer coating of flux for a sufficient length of time to refine the grain structure.

The degree of fusion between the weld and the parent pipe metal is indicated by chemical analysis of the weld metal, which usually runs .18 percent carbon and .95 percent manganese. Thus, during the welding process, the mild steel electrode has picked up from the pipe and flux several points of carbon and manganese as well as small quantities of other elements which add strength to the weld. This applies particularly when pipe to specification API-5 LX-52 is used, which has an approximate range of .20 to .30 percent carbon and .85 to 1.25 percent manganese.

During the first two weeks operations, numerous physical tests were taken on the welds produced under field conditions. Almost every other weld was subjected to X-ray examination to enable the inspectors to check thoroughly the quality of welding. These prolonged examinations indicated that the welding was equivalent in quality to those produced under more ideal conditions found in factories making longitudinal pipe welds by the submerged arc process. The adaptation of this process for field use apparently has lost none of the high qualities associated with submerged arc welding. This is understandable, as the machine operator is provided with meters which indicate the actual welding amperage and voltage and a means of regulating the speed of welding. This positive and accurate control insures that every weld has the same structure, consistently high in quality, with freedom from the defects sometimes associated with field welding.

■ CONTINUED ON PAGE 218

Internal line-up clamps provide a special metal backing ring when hand stringer beads are not used.



In this photograph, the machine is shown actually making a weld at the pipe line construction job site.

FIGURE 1. General view of Sunset station, showing heat exchangers in yard in front of pump building (left) and boiler house (right).

Station Automatically

• Heats and Ships Crude

• Telemeters Data

By GILBERT M. WILSON, WORLD OIL Staff

AN INSTRUMENT-operated pipe line pump station is being used successfully by Union Oil Company of California in the Taft-Maricopa district of the Midway-Sunset oil field in Kern County. The automatic features incorporated in design of the station (Figure 1) are (1) automatically operating boilers which heat the oil and hold it at a pre-determined temperature; (2) heat exchangers whose operating temperatures are governed automatically by special pneumatic controller equipment; (3) an automatically operating boiler feed water supply system which operates in a closed system; (4) automatically controlled, gas engine driven pumps which dispatch a pre-determined quantity of crude at a practically constant rate of flow; and (5) a telemetering system that delivers pressure, temperature and rate of flow information constantly to the next station, located in the McKittrick area some 30 miles distant, and from which station are observed the various conditions existing in the automatically controlled and largely unattended Sunset station.

Prior to its conversion to an automatic operating basis, this station could not be operated as economically as desired because the volume of crude being dispatched through the station was diminishing as the production in the area declined. Not enough oil was being shipped out of the station to keep it in continuous operation. A crew was being brought in for a ten-day period every month to heat the oil collected in the two 55,000-barrel tanks and pump it through the company's eight-inch line to McKittrick and on to Port Avila on the coast. Gravity of the oil averages about 13.5 degrees API.

This intermittent operation, however, proved to be costly and caused interruption of jobs elsewhere as men were brought in to the station on these occasions. Engineers of the pipe line department set about designing a suitable form of automatic control that would eliminate the intermittent operation. That they succeeded is

WHEN DECLINING crude production made continuous operation of Union Oil Company's Sunset station uneconomical, the station was converted to push button operation by adding instruments and telemetering equipment. This station, which heats as well as ships crude oil, can be operated and observed from a station 30 miles distant. Only minor maintenance work, chart changing and gauging are required of operating personnel.

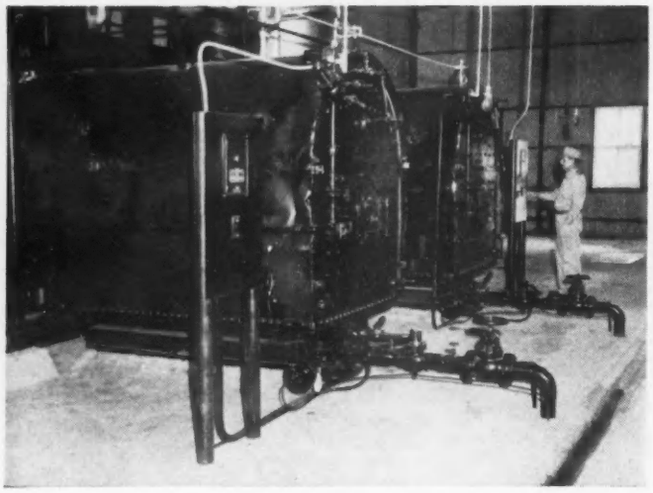


FIGURE 2. This view inside boiler room shows automatically operating boilers which generate 15-pound steam for heat exchangers. Gauger is pressing button which actuates controller mechanism that, in turn, admits gas to fire box and energizes spark type igniter.

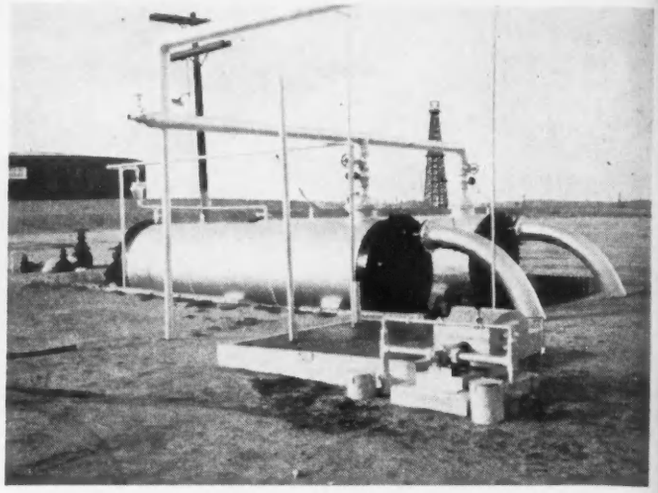


FIGURE 3. Shown here is heat exchanger installation which heats oil coming in from storage tanks at left. Note self-actuated temperature controller device in steam line above each exchanger which holds oil to 160° F. Automatic waste sump is in the foreground.

seen in the much smoother operation and reduced cost of labor, fuel and maintenance that has resulted since it was placed in operation.

Station Unattended

The new self-operating station, only recently placed in full operation, is designed to heat the crude oil to the desired temperature and pump it through the pipe line at a pre-determined rate of flow. The speed of the pump engine is controlled by a governor which, in addition to the regular mechanical governor, has an overriding control. This overriding control assumes control of the engine and slows it down, or stops it if the suction pressure drops below a predetermined minimum or if discharge pressure approaches a certain maximum.

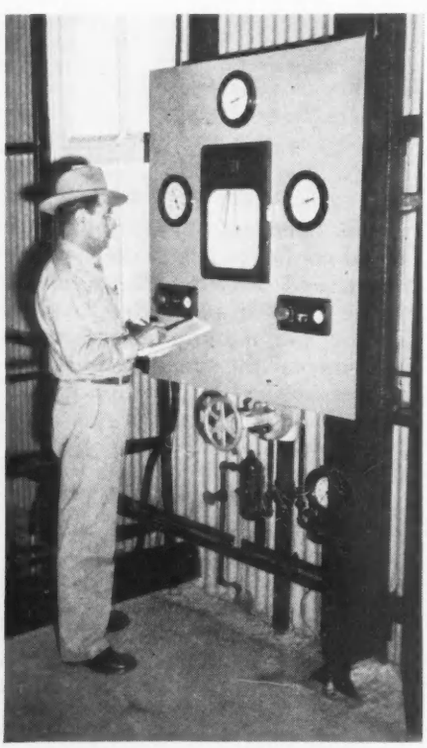


FIGURE 4. Gauger reads pressure, temperature and rate of flow on instrument panel in pump building. Valve below panel is bean bypass line used to start cold oil plug after plant has been shut down. Small panels below recorder controller are manual units.

Through the telemetering system that relays all operational data to the McKittrick station, the engineer on duty at the latter point can tell immediately if a line should break or other trouble occur and can take steps to remedy it. Tentative plans now being worked out will eventually make it possible for the McKittrick operator to shut down the Sunset plant entirely merely by pushing a button.

The principal tasks required of company personnel at the Sunset station are the daily gauging of the tanks, changing of charts and minor maintenance work.

The Sunset plant operates under roughly two separate systems: heating and pumping. The heating system operates automatically, heating the oil as it is being withdrawn from either of the two 55,000-barrel storage tanks to 160° before it enters the pumping plant. Heating is done with two locomotive-type, 85-horsepower boilers (Figure 2), only one of which is now in use, the other being maintained as a standby unit. With the exception of the actual lighting-off of the boilers, the units are fully automatic in operation. Fuel supply, boiler pressures, level control, condensate return and make-up water supply are automatically regulated to suit existing conditions.

The boilers are started by pressing a button on a control panel near the front of the boiler setting. This causes a valve to open in the pilot fuel line, admitting fuel to the fire box. As gas enters the fire box, a spark type igniter is energized and the resulting spark ignites the pilot gas. After the flame is established, the main gas valve opens. This operation also could be made fully automatic, but for the present time, it is preferred that the boilers be started manually.

Low pressure steam generated by the boiler passes through an overhead insulated pipe line to a pair of large heat exchangers, Figure 3, located on the main oil suction line

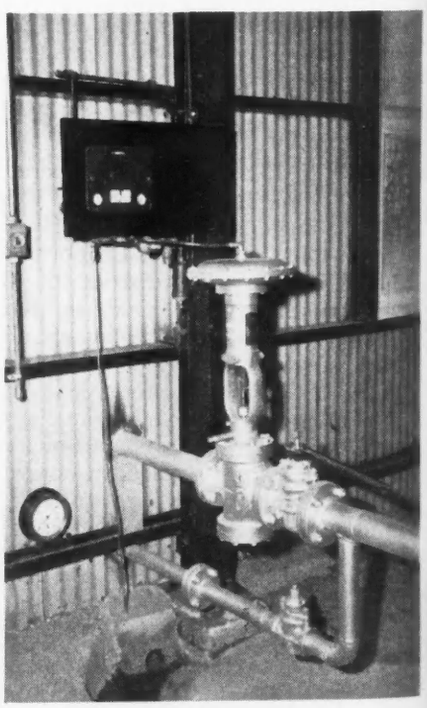


FIGURE 5. Controller on incoming fuel line in boiler room which varies the amount of gas to go to boilers. Input to fire box varies as steam demand varies. Boiler pressures are held at between 12 to 15 pounds per square inch.

80% of the WORLD'S
High Pressure Wells
are Controlled by
W-K-M Valves
R. Book '51
W-K-M Company
OIL FIELD, PIPELINE & INDUSTRIAL EQUIPMENT
HOUSTON, TEXAS, U.S.A.
LOS ANGELES
Cable Address: "WILKOMAC"
Export Office: 30 Rockefeller Plaza, New, York, N.Y.

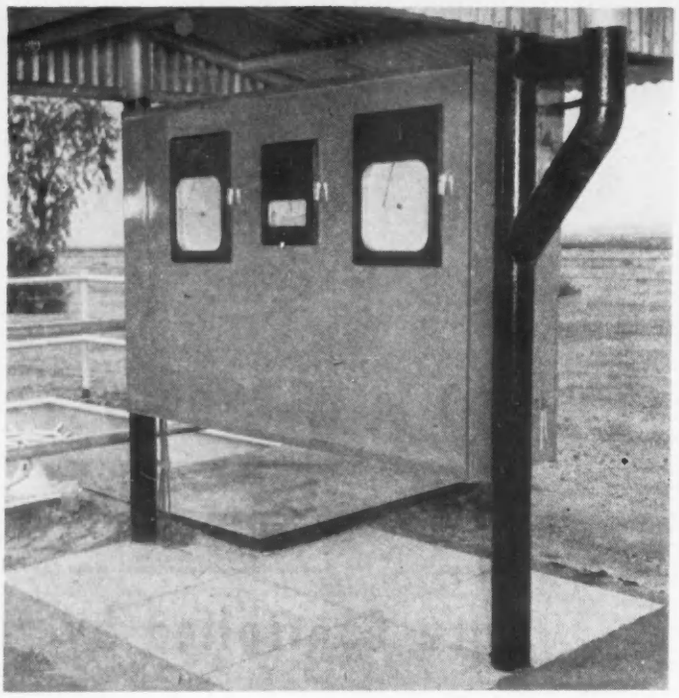


FIGURE 6. Instrument and transmitter panel mounted above start of eight-inch line that delivers heated crude to McKittrick station. Temperature, rate of flow and pressure data registered on these instruments are automatically telemetered to similar panel at McKittrick.

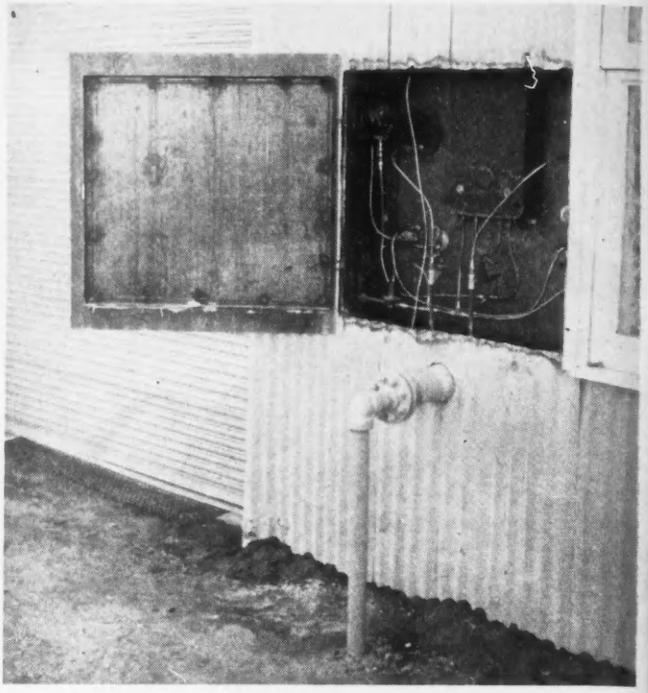


FIGURE 7. View of back side of pump room instrument panel showing manner in which outside wall is cut out and hinged door mounted to permit easy access and inspection of instrument lines and fittings. Door is padlocked to prevent unauthorized tampering.

entering the station from the storage tanks. The steam imparts heat to the incoming crude and the condensed steam, collecting in the underground trap partially visible in Figure 4, is automatically pumped back for re-use in the boiler. Controller devices automatically govern these operations. A zero-to-15-pound range controller on the boiler fuel gas supply line (Figure 5) varies the amount of fuel required to hold the boiler at the desired 12 to 15 pounds per square inch pressure. A thermostatic temperature controller on each of the heat exchangers keeps the temperature of the crude at 160° F. as it leaves the exchanger. A feed water controller and level alarm device at the boiler setting keep the boiler supplied with water from both the condensed steam return and the makeup supply in an elevated tank. If for any reason the electrically-powered feed water pump is unable to deliver water to the boiler and the level reaches the low-alarm level, the fuel gas supply line is closed off and the plant shuts down.

Pumping Regulated by Controllers

Crude oil coming in from the heat exchangers enters the pumping plant which is made up of two gas-engine driven 2½ to 5 x 10 duplex pumps. Only one of the units is currently in use, the other serving as a standby. Under normal operating conditions, suction pressures are not allowed to drop below approximately two pounds per square inch and discharge pressures are not allowed to exceed 800 psi. Between these limits, the engine speed is limited only by the maximum range of the pre-set mechanical governor. When either of these two extremes in pressure is reached, a controller actuates a diaphragm lever motor on the engine throttle (partly visible in Figure 8) and starts to throttle down the engine. If the trouble should persist, causing the engine to be throttled down still further, a mercury switch on the control air line between the controller and engine throttle will break the engine ignition and the plant will shut down.

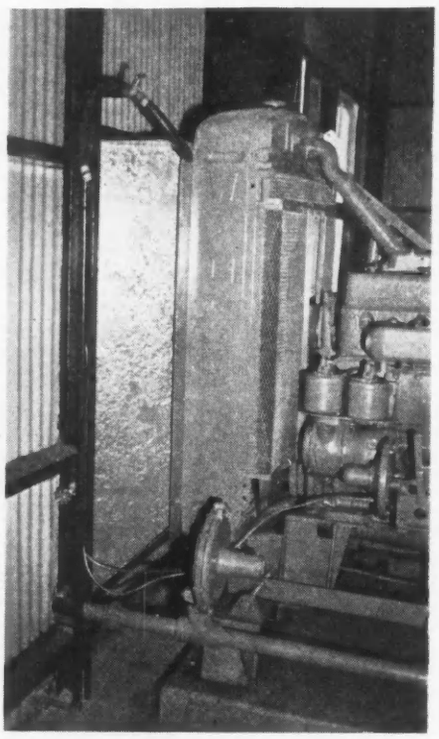
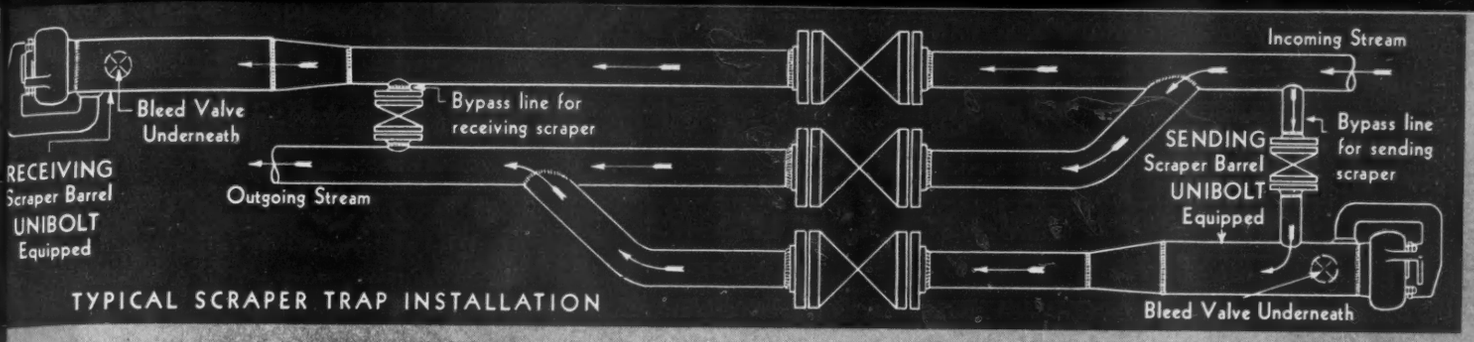


FIGURE 8. Closeup view of pump engine radiator installation, showing manner in which engine heat is directed outside through opening cut in side of building.

During the summer, when outside temperature is high enough to keep the oil warmed sufficiently to permit its being pumped, the heat exchanger system is not used. The present station is remarkably efficient and easy to operate when compared to the old steam-powered pumping plant with its high operating cost, fuel cost and greater amount of maintenance.

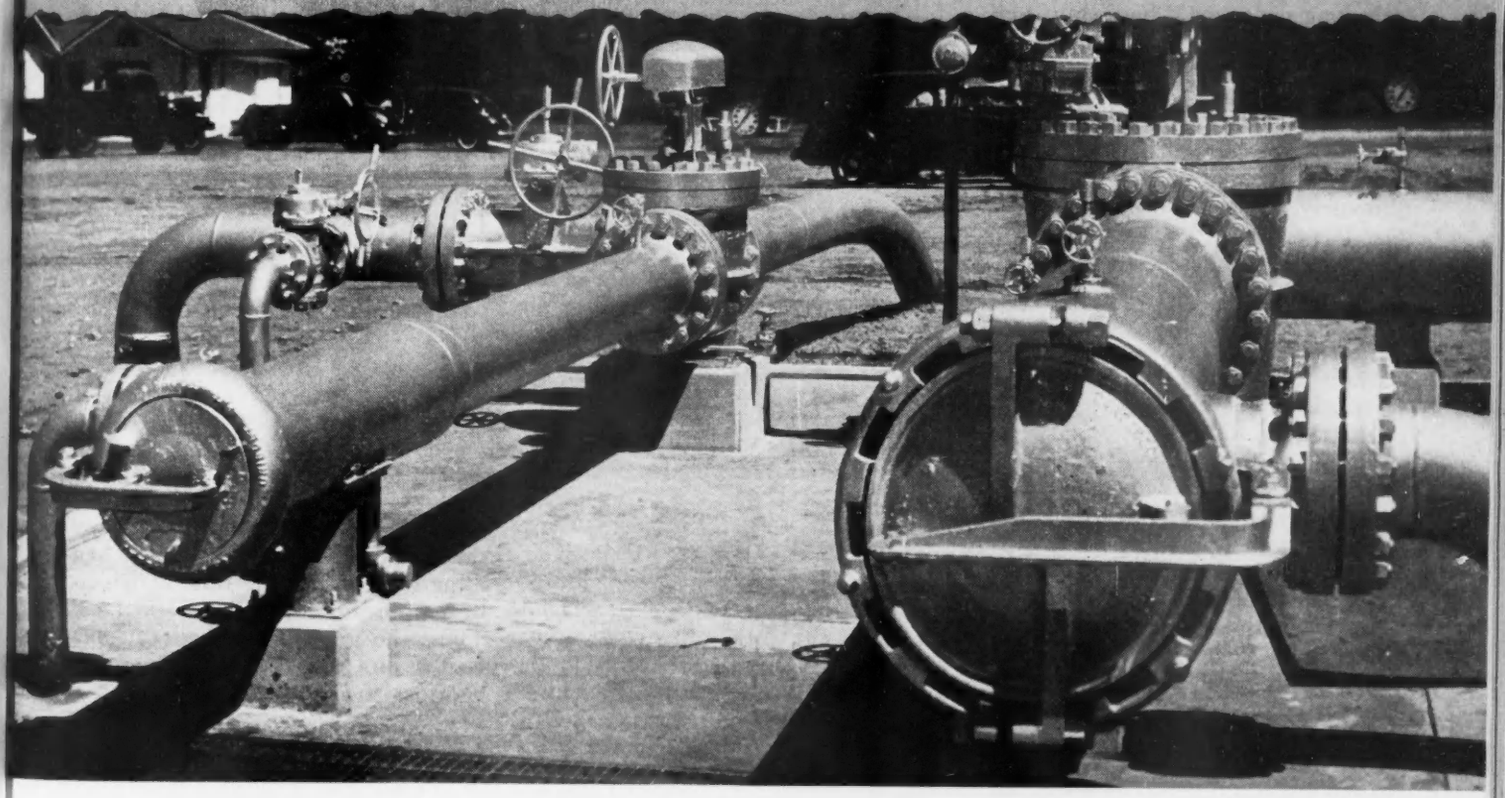
Telemetering Circuits

The telemetering system relays all necessary operational information to the McKittrick pump station 30 miles away. It operates on a time-duration impulse basis and utilizes the company's regular telephone line as a carrier. Signals transmitted to the McKittrick pump station are independent of voltage, frequency or line resistance and, in fact, pass through the company's switch board uninterrupted and unaltered by the normal use of the telephone circuits. The three types of data transmitted are pressure, rate of flow and temperature. At the Sunset station the instruments recording or indicating these three sets of data are mounted on a panel installed directly over the pipe line just outside the pump building. Shown in Figure 6, these instruments are, left to right: temperature transmitter and recorder; flow transmitter



TYPICAL SCRAPER TRAP INSTALLATION

THE EASY WAY TO CATCH A PIG!



The oversize barrel does the trick. Note in the above sketch of a typical scraper trap installation how an oversize barrel on both the sending and receiving ends of the line provides ample clearance for the pig (which has the same o. d. as the pipe in which it is run). No sidebooms, tractors, rams and strongarm men required. Line pressure does the heavy work.

But that's only half of the story. To further simplify the job, all you need do to open the UNIBOLT Hinged Scraper Trap is release two bolts and the blanking plug swings open like a door. No heavy lifting. Nothing to fall on workmen. No time-consuming blind flanges to make up. No danger of leaks — the UNIBOLT self-sealing oil-resistant seal ring assures a pressure-tight seal.

UNIBOLT SCRAPER TRAP with oversize barrel

Wherever multi-bolt flanged couplings and closures are now being used . . . on strainers, scrubbers, mist removers, terminal manifolds, blowdowns or other pressure vessels . . . UNIBOLT Couplings will serve you better. Send for literature.

THORNHILL-CRAVER COMPANY • HOUSTON, TEXAS

and indicator; and pressure transmitter and recorder. At the McKittrick station temperature data is received on an indicator: flow is received on a combination recording and integrating instrument; and pressure is received on an indicator.

A quick glance at the telemeter data on his instruments enables the McKittrick engineer on duty to see exactly what is happening at the distant and generally unattended Sunset station. Although he will know within minutes when anything happens which might require attention at the Sunset station, it is probable that before a crew could arrive to take care of the difficulty, the plant, because of the efficiency of its automatic controls, long since would have shut itself down with little or no damage done. It is anticipated that such instances will be rare, for the gauger who daily visits the plant, or the maintenance man who occasionally inspects the equipment, would note anything that ultimately might require attention.

Cost-Saving Features

Contributing to the efficiency and smooth working of the automatically operated station are several smaller features which merit attention and description.

To reduce the heavy load that exists when the plant is started up following a shut-down period of some duration, a means is provided for simplifying the pumping-out of the cold oil plug. A bypass line which connects discharge with suction is equipped with a flow bean located conveniently below the main control panel in the pump room. On starting up the pump, this bypass bean is opened wide, permitting part of the heated oil to circulate between discharge and suction and thus enable the pump to operate at a more normal speed. As the plug gradually is pushed out into the line, the flow bean gradually is closed off, until the pump once again is handling the normal volume of oil. The bean, visible in Figure 4, is closed during normal periods of operation.

Of considerable aid in the servicing, inspecting or repairing of instruments or fittings in the control panels is the method used in mounting them. Panels were designed so that easy access could be gained from the rear and without having to remove either the front panel or the individual instruments. In the pump house, a corrugated iron building that was a part of the original plant installation, a square section of the outside wall was cut out directly behind the instrument panel. Shown in Figure 7, the opening was fitted with a steel plate door, hinged on one side and equipped with a hasp and padlock to eliminate possibility of unauthorized tampering. Inspection or repair of a fitting or instrument line can be done in a fraction of the time that might be required if the main panel inside the plant had to be dismantled.

A similar installation is provided for the sheltered and weather-proof instrument board on the discharge line just outside the plant. In this case, the entire enclosed panel is constructed of sheet steel, the back being hinged so that it can be swung back to expose the entire back side of the instrument panel.

A centralized waste oil sump, located in the yard beside the heat exchangers, is designed to collect all waste oil, crude oil spills and condensate bled from lines. The sump (Figure 3) is concrete lined and is equipped with a mercury switch float which automatically starts and stops a small electric-motor driven pump which empties the sump. This waste disposal system is of considerable value in keeping the plant buildings and surrounding area clean and free of inflammable fluids.

The pump house is automatically vented as a result of the manner in which the engine radiators were mounted. As can be seen in the Figures 1 and 8, engine and radiator units are installed so that radiators face against and fairly close to the wall of the building. Rectangular openings were cut out of the side of the building and strips of salvaged tank steel cut to the proper size, were bolted in place between the radiator and wall surface. With the exception of the radiator itself, the interior of the building thus is closed off from the outside. Radiator fans were set so that air, which normally would be drawn in through the radiator, now is directed outward through the radiator and on outside. This causes fresh air to be drawn into the building through vents in the roof. As long as the pump is operating, the building is automatically ventilated and air conditioned, a factor which reduces to practically nil the chances of explosive gases accumulating or exploding inside the structure.

Placed in automatic operation approximately nine months ago, the Sunset pumping station is performing in a manner that does credit to the skill of design and engineering that went into the system. It has operated trouble-free and without doubt will easily repay in increased efficiency and in fuel and man-hours saved, the cost of equipping it for automatic operation.

Submerged Arc Unit

■ CONTINUED FROM PAGE 212

When the first pass of submerged arc welding is applied on to a hand stringer bead (as was done on most of the welding in a recent Illinois job) the machine is set with sufficiently high amperage to disperse any undercutting and to boil out the nonmetallic inclusions generally found in manual stringer beads.

A Rockwell hardness test taken from a typical sample of this type welding shows results as follows:

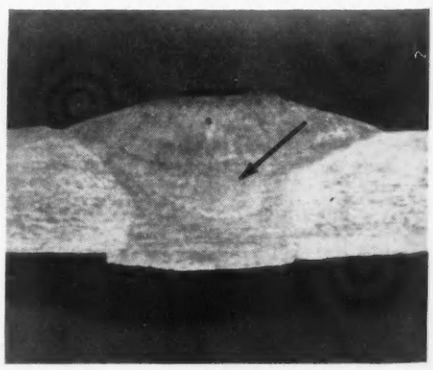
Rockwell Hardness Test
B-Scale Units

Weld Metal	Parent Metal
86	74
91	76
86	76
89	70
87	72
87.8 average	73.6 average

These readings converted into tensile strength in pounds per square inch show the welded metal has more strength than the pipe. Subsequent 180 degree face and root bend tests indicated the welds had adequate ductility.

An application predicted for this machine is its use in welding one-half-inch to 1⅛-inch thick wall pipe for river crossings. Since the setup time is approximately the same for all wall thicknesses of pipe, the ratio of handling time to welding time is reduced in proportion to the wall thickness. Thus, the greater the wall thickness of the pipe, the more advantageous becomes the use of the machine.

An important application is the use of the equipment to weld pipe down the right-of-way into sections of five, six and more joints. When this method is used to its fullest extent by tying in these multiple sections, the rate of pipe line construction progress is increased.



The area of fusion between the weld and the pipe. Arrow indicates the zone of penetration of the second welding pass into the first pass.

Why the FIRST names in pipelines depend on the FIRST* name in line pipe

*FIRSTS by A. O. SMITH • Welded line pipe • Internal expanded pipe • Light wall large diameter pipe • World's largest producer of large diameter welded steel line pipe

"Straight as a die" can be taken literally when oil men discuss A. O. Smith Line Pipe. That's because A.O. Smith's internal expanding process stresses the pipe beyond its yield point—and when pipe is stressed beyond its yield point by uniform internal expansion it automatically comes out round, straight, and consistently of the right diameter.

Uniformly round, straight pipe eliminates time-consuming "line-up" operations in the field and makes possible consistent "stringer bead" welds.

In addition, the A. O. Smith expanding process produces pipe of high yield strength permitting higher operating pressures without the use of alloy steels and their accompanying special welding practices. No wonder the *first* names in pipelines depend on the *first* name in line pipe!

A. O. Smith Line Pipe is available in a complete range of sizes and wall thicknesses, from 8⅝ in. to 36 in. in diameter.

A. O. SMITH 77th ANNIVERSARY 1874 · 1951

A.O.Smith

LINE PIPE • CASING

Atlanta 3 • Chicago 4 • Dallas 2 • Denver 2 • Houston 2
Los Angeles 14 • New York 17 • Pittsburgh 19 • Salt Lake City 1 • San Francisco 4 • Seattle 1
Tulsa 3 • Washington 6, D. C. • International Division: P. O. Box 2023, Milwaukee 1

DEPENDABILITY *through* RESEARCH *and* ENGINEERING

38-Year-Old Pipe Reclaimed

By JAMES JOSEPH

Old line near Mojave is uprooted by side-booms. Forty-foot sections were lifted out, cut by torch at the collar.

BECAUSE OF the scarcity of small diameter pipe, reclaiming used pipe has once again become important to the pipe line industry. General Petroleum Corporation recently reclaimed not only the pipe from a system no longer in use, but the tankage and pump stations as well.

A PIPE line may not have nine lives, but as far as General Petroleum Corporation is concerned, it certainly has two.

That's the theory upon which the oil company operated when it awarded a removal and installation contract to Bechtel Corporation to tear out 43 miles of 38-year-old Lebec to Mojave, Calif., eight-inch line and re-lay it from San Ardo to Estero Bay on the California coast. The old line, originally laid in 1913, connected General Petroleum's Lebec refinery in the Tehachapi Mountains with the Mojave refueling station of the Santa Fe Railway. During 38 years of operation, the line carried 133 million barrels of fuel oil for steam locomotives. However, with the advent of diesel en-

gines, trains no longer needed to refuel at Mojave and the line fell into disuse, thus motivating its relaying.

This project is monumental for its re-use of salvaged material. Besides the line, storage tanks were likewise moved from the old line to the new.

Construction-wise, the project is a concrete example of new pipe laying techniques compared to old. Bechtel required about 90 days for the complete job. First, ditchers cleared away from two to four feet of overburden. Next, two sideboom tractors with torch crews behind straddled the line, looped double-eyed cable slings around 40-foot sections, and uprooted them. Every other threaded collar was halved with a cutting torch, separating the pipe into 40-foot lengths. These sections were loaded onto trucks and hauled to San Miguel, the staging area, a distance of about 170 miles.

Portable Plant

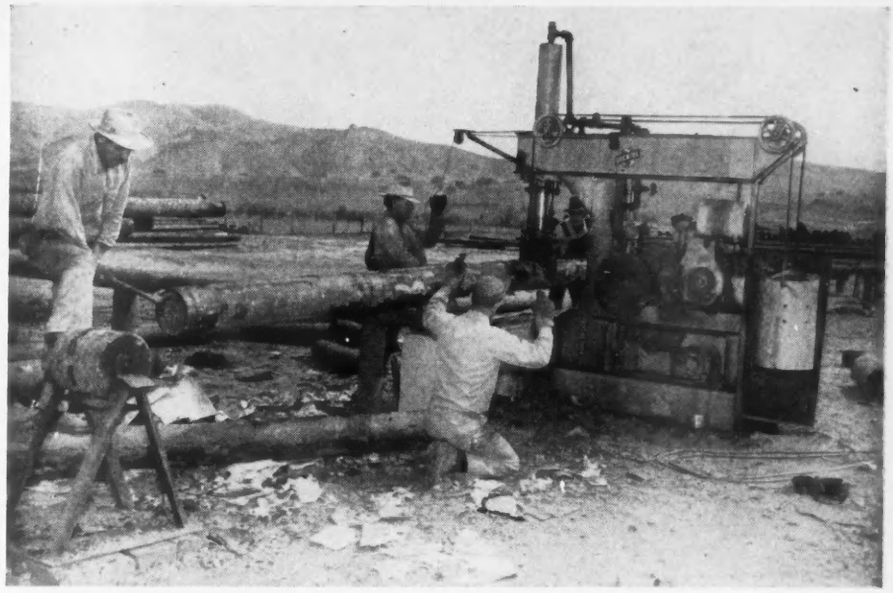
At San Miguel a portable reclamation plant was set up which performed six operations to prepare the pipe for re-use.

- Crooked 40-foot sections were straightened in an aligning machine.
- Gas-fired torches, on 20-foot pipe lengths, were inserted into each section of pipe to melt the asphalt coating.
- Once the coating had melted and was cleaned off, the pipe was machine beveled, cutting off the collars and threads and leaving approximately 20-foot lengths of pipe.
- These 20-foot sections were then processed through automatic shot-blasting machines which thoroughly cleansed their exteriors.
- The 20-foot sections were welded into 40-foot lengths.
- The pipe was then subjected to hydrostatic pressure testing, at 900 pounds per square inch. Only three welded sections were discarded as a result of hydrostatic testing.

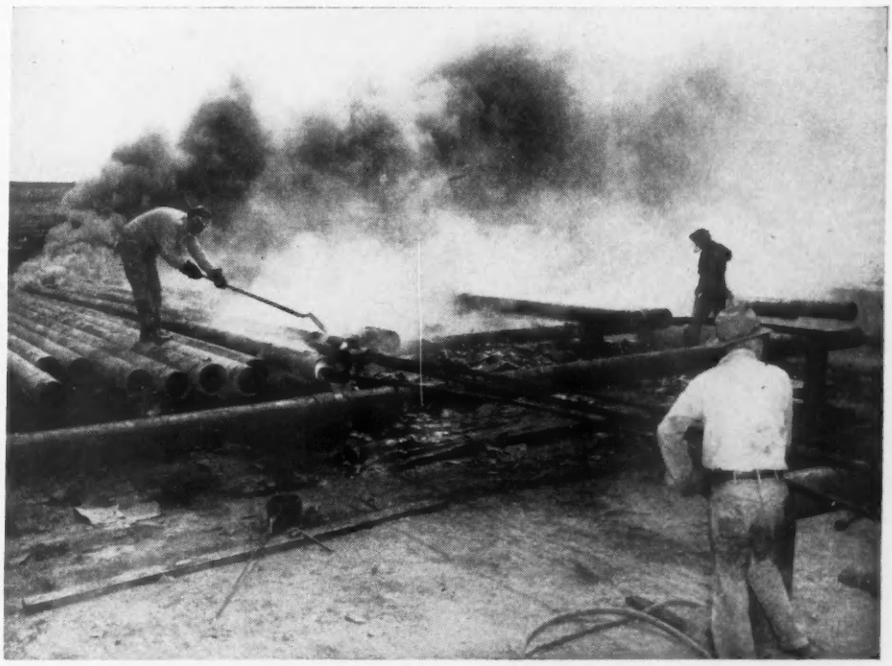
This points up the longevity of the old pipe. There were several reasons why corrosion had taken no toll. The original pipe was laid in dry, sandy desert soil. It was relaid in practically the same type of soil. The 38-year old coating—the "cigarette wrap"—was found in excellent condition.

General Petroleum was able to salvage about 2650 tons of scarce steel by this rehabilitation program, or about 98 percent of the old pipe.

The San Ardo line which went into operation about mid-June, is 40 miles long. Three new pumping stations are

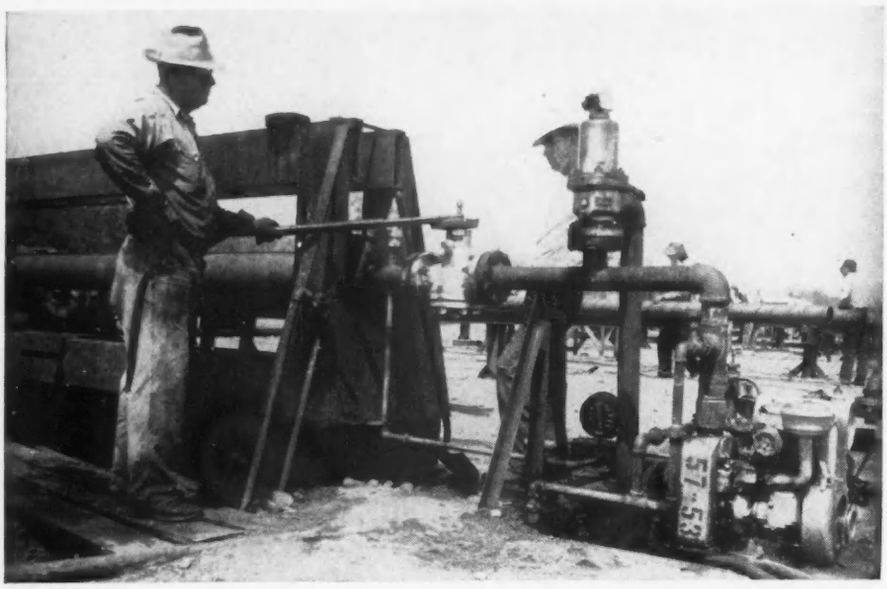


Old pipe, not yet cleaned, was first straightened where necessary.



Gas-fired torches on the end of 20-foot pipes were inserted in pipe sections to heat them, thus melting coating.

Shot-blasting cleaned outer pipe surface.



Each 40-foot section, after rehabilitation, was hydrostatically tested to 900 pounds per square inch. Only three sections were discarded as unfit.

Salvaged line being relaid near San Ardo, Calif.

spaced along its length, one at San Ardo, San Antonio and Adelaida, Calif. The line's terminus is at Estero, where existing storage facilities and the submarine tanker-loading line belonging to Standard Oil Company of California are being leased.

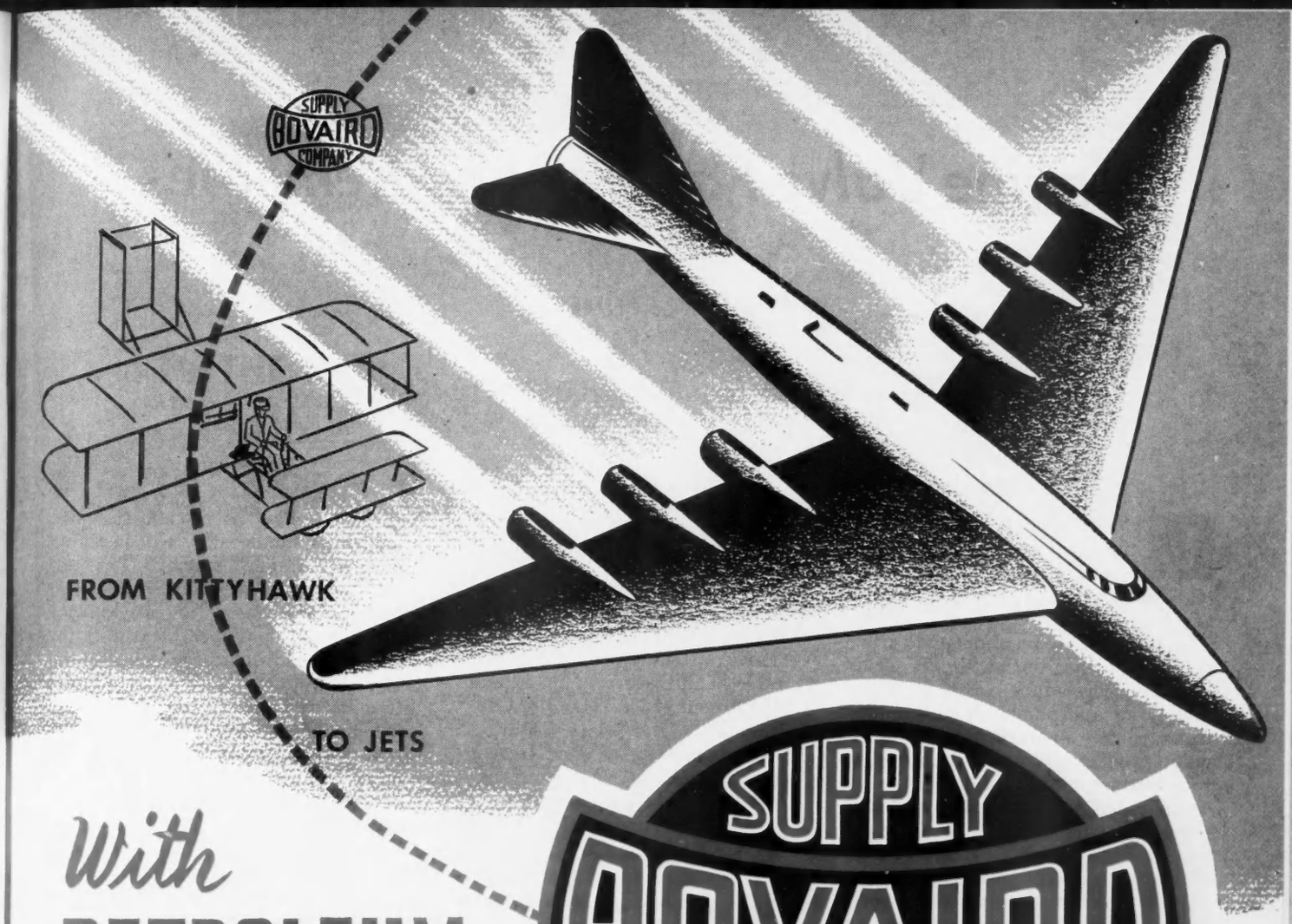
Particularly significant from the standpoint of metal conservation is the establishment of these new pumping stations, which will deliver 18,000 barrels per day from the San Ardo field.

Storage tanks, steam plants and pumping facilities at these new stations are practically all salvaged from other General Petroleum installations. Two 55,000-barrel storage tanks salvaged from Mojave were ripped into small sections by cutting torch and transported north. These tanks originally were riveted, and because they were fabricated from small sheets, a great number of rivets were used. To remove these rivets and replace them would have been costly. Instead, the torched sections were welded, leaving the riveted joints intact. In cutting the tanks, sheets were straight-cut and then butt-welded. Engineers figured this was far cheaper than removing and replacing rivets. The three steam-powered stations have likewise been salvaged from the old Mojave line. Each station will reheat oil passing through the line.

A smaller line will parallel the eight-inch San Ardo line and will carry light petroleum products, which will be blended with the San Ardo crude.

Threaded ends were cut off by beveling torch. Waste per 40-foot section was, on the average, less than two feet.

Riveted storage tanks were cut up between rivets, and welded together after being transported to the erection site.



With PETROLEUM and....

SUPPLY BOVAIRD COMPANY

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER

Aviation is a great development made possible by your petroleum industry. In 1903, when the Wright Brothers made the first successful flight, Bovaird had been serving the growing oil industry for 32 years. Today, after 80 years of service to, and growth with the oil business, Bovaird gratefully acknowledges the friendship and confidence of the industry in the past and its opportunity and responsibility to serve in the years ahead.

Bovaird's experienced personnel, complete stocks and 22 strategically located offices and stores are ready at any time to give the fast, dependable service you want.

OFFICES AND STORES

ILLINOIS—Clay City, Grayville, Salem
KANSAS—Chase, Great Bend, McPherson, Pratt, Russell, Wichita
OKLAHOMA—Duncan, Oklahoma City, Pauls Valley, Ringwood, Sapulpa, Seminole, Tulsa
TEXAS—Borger, Dallas, Midland, Odessa, Pampa, Snyder

"Buy From Bovaird"

THE Bovaird SUPPLY COMPANY

GENERAL OFFICES
TULSA, OKLAHOMA

80 YEARS OF PROGRESS WITH THE OIL INDUSTRY

Engine Valve Failures and Remedies

By A. L. POMEROY

Director of Developments, Thompson Products, Inc., Cleveland

THE PRIMARY CAUSE of engine valve failure is excessive valve temperature. Such failures, in most cases, can be traced to inadequate design and operational practices, which influence valve temperature. This article was prepared for WORLD OIL from a paper, "Valve Rotation —Its Impact on Engine Design and Operation," delivered before the Mid-Continent Section, Society of Automotive Engineers, Oklahoma City.

LARGE-SCALE field investigations and extensive laboratory tests indicate that more than 90 percent of all valve engine failures are caused by sticking or burning. This may readily be understood when considering that during the life of an average heavy-duty valve it opens and closes approximately 100 million times, slides about 800 miles in its guide, and is alternately required to seal against and to release flow of gases containing 70 million British thermal units. Valve-head temperatures range as high as 1350° F. Furthermore, much of this duty is under varied operating conditions, over large ranges of ambient temperature, with fuels and lubricants differing widely in composition and performance. This is particularly true of engines used in the pipe line industry.

When premature valve failures occur, the engineer should look very closely into maintenance, operation, or fuel and lubricant used. Frequently the causes of the troubles are obscure or seemingly insignificant.

Insufficient tappet clearance resulting in blowby at the face and seat is one of the most common and obvious causes of valve burning. Holding the valve off the seat will greatly increase valve-head temperature (Figure 1). When the valve is exposed to continuous blowby, failure will soon follow as no known valve material or facing alloy will last long under continuous blowby. The obvious method of overcoming this valve burning problem is to provide for more adequate tappet clearance for all anticipated operating conditions.

In many cases, engine operators attempt to eliminate this problem by setting tappet clearances considerably greater than those specified by the engine builder. While this expedient will preclude holding the valve off the seat, it frequently results in valve breakage. Camshafts are designed with a seating ramp to decelerate the valve so as to seat it at relatively low velocity. By increasing tappet clearance over that for which the cam is designed the valve will close at a higher point in the lift curve where valve velocities are higher. The resultant seating shock is a common cause of valve breakage.

Worn valve guides constitute another factor resulting in valve burning. Figure 2 indicates effect of valve guide clearance on valve temperature. Data from an extensive investigation on the heat transfer characteristics of sodium-cooled aircraft valves show that increasing the valve guide clearance from .003 to .010 inch will raise the valve-head surface temperatures approximately 150° F. This same trend applies to heavy-duty,

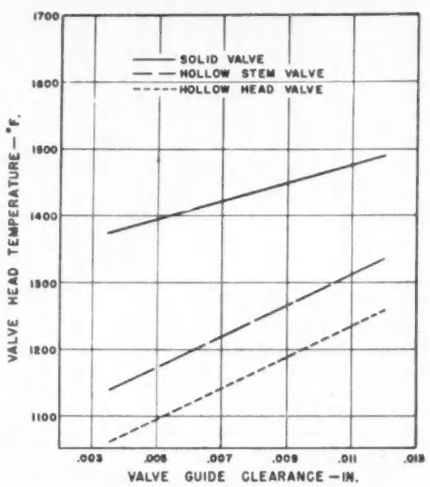


FIGURE 2. Effect of valve guide clearance on valve tempetarure.

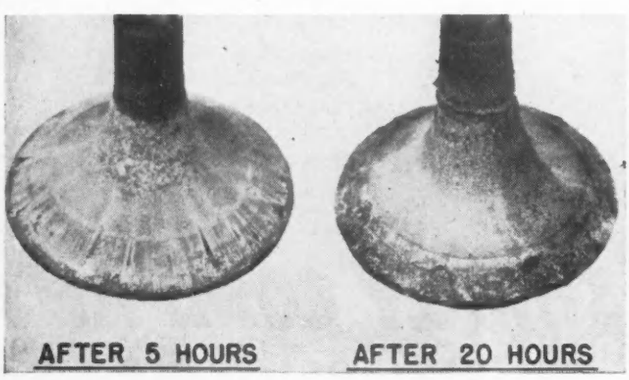


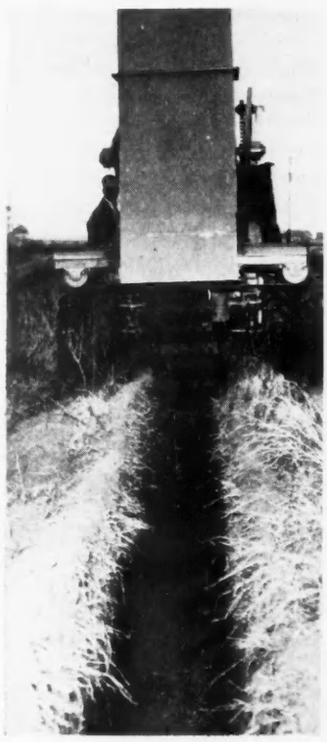
FIGURE 1. Valve burning caused by insufficient tappet clearance.

FIGURE 3. Valve failure resulting from deposit flaking.

THE WORLD'S FASTEST MOBILE DITCHER!

PEWTHERS' "EARTHRIPPER"

Digs Two City Blocks in One Hour



Pewther's EARTHRIPPER is particularly suited for gas lines, extensions and house-to-street service lines. Any small ditching job . . . in the oil fields . . . on contruction jobs . . . for utility ditching that requires ditches 10", 14", or 18" wide . . . is duck soup for this new, *different* Pewthers ditcher. The EARTHRIPPER tears though any kind of soil . . . from sand to "Texas gumbo" . . . at a maximum depth of 5 feet at the rate of 20 feet a minute!

If you look out over a field or a real estate project and think you see a Ford truck digging ditches, don't hurry to an oculist. It's probable that you are gazing at the latest development in ditchers for gas, water, cross-country pipe lines and the laying of telephone cables and conduits. While most ditchers are of the tractor type, this innovation in digging equipment has been standardized to Ford trucks. This new ditcher offers the man who has small ditching problems just what he needs—fast, efficient, *economical* digging.

ECONOMICAL The EARTHRIPPER, fastest mobile ditcher in the world, saves time and money through reduced labor and maintenance costs. One man can handle your ditching problem, from driving the truck to the ditch site to lowering the boom and opening the earth at the rate of twenty feet a minute! Built for hard use and daily operation, the EARTHRIPPER has low maintenance costs because of standardization of automotive parts.

EFFICIENT New and unique in design, the EARTHRIPPER is the first ditcher to be attached to a truck. Its boom and bucket line eliminate the necessity for great weight, for the harder the digging, the greater the pull on the machine to the ground. Thus the new Pewthers ditcher tunnels under and literally "rips" out the earth, shaving the ditch sides close and leaving the bottom smooth and clean. Centrifugal force keeps the teeth clean of mud and packed dirt.

VERSATILE The Pewthers EARTHRIPPER digs vertical ditches on any kind of terrain under almost any digging condition. On slopes the truck and tires follow the contour of the ground; the digging equipment remains vertical for straight, clean ditching. The EARTHRIPPER is versatile because it is mobile. On the highway its speed is the speed of the truck. The raised boom clears telephone wires and tree branches making transit easy and speedy, even in heavy city traffic.

PEWTHERS DITCHERS COMPANY • 3530 Mansfield Road
Shreveport, Louisiana

Send for the folder on the new Pewthers ditcher, the EARTHRIPPER. Learn for yourself how the EARTHRIPPER can save time and money on any small ditching job! Ask for a demonstration before purchase . . . at any point in the United States!

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

PEWTHERS DITCHER COMPANY

3530 MANSFIELD ROAD • SHREVEPORT, LOUISIANA

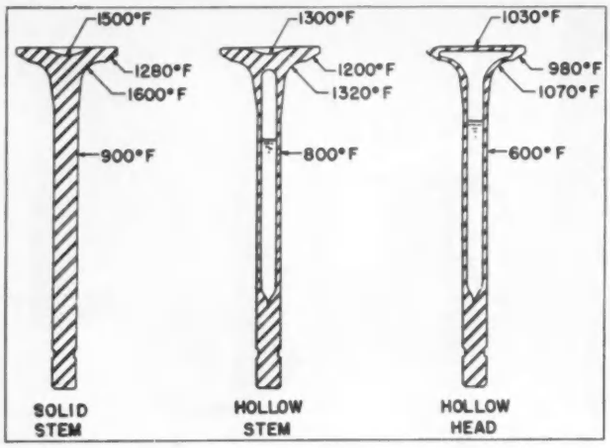


FIGURE 4. Effect of sodium cooling on valve temperature.

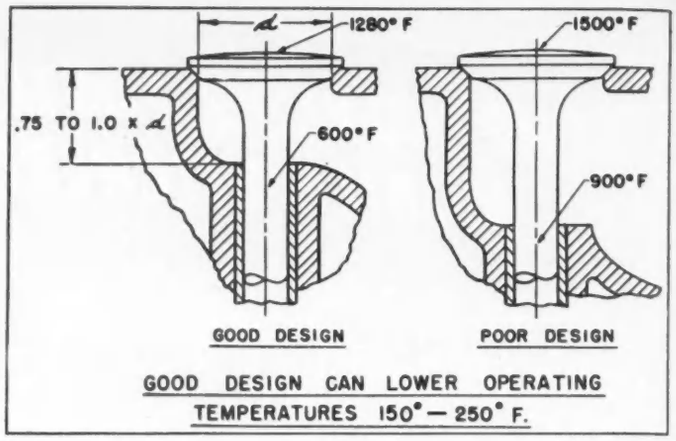


FIGURE 5. Comparison of port designs.

sodium-cooled heavy-duty engine valves and, to a lesser degree, to solid valves. A large clearance may also permit products of combustion to enter the guide and combine with oil to form carbonaceous mixtures and heavy, gummy deposits on the valve stem. Worn valve guides also lead to misaligned valve heads, resulting in poor valve seating with blowby and increased valve-head temperatures.

Valve sticking, if prolonged, is invariably followed by valve burning, since the valves are not seating for the proper length of time. This condition may vary all the way from sluggishly operating valves to those that have frozen in their guides. Assuming proper original valve stem to guide clearance, sticking is usually the result of accumulations on the valve stem and in the valve guide. At certain high temperatures the oil on the valve stem tends to oxidize and decompose forming hard, coke-like and resinous materials. The degree to which such deposition takes place varies with the fuel and oil and the operating conditions of the engine. Dirt from the intake air, and gum and lead compounds from the fuel become mixed with the varnish to form hard deposits that adhere to the valve stem and guides. These deposits, if allowed to accumulate, ultimately impair free movement of the valve in the guide. Field reports have indicated an increase of intake valve sticking attributed to partial decomposition of the fuel while in the intake system.

A primary cause of valve burning is face deposits originating from the fuel or oil which tend to form on the valve face and subsequently break away. The flaking away of the deposits creates a blowby path past the valve face, thus raising its temperature locally (Figure 3). Deposits of this nature can very quickly lead to valve failure through accelerated guttering of the valve face. They probably account for more valve failures than any other single cause.

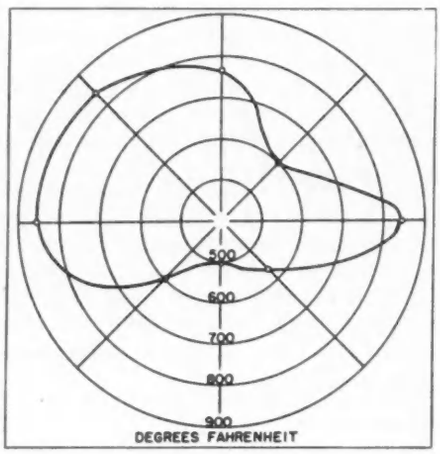


FIGURE 6. Valve seat insert temperature.

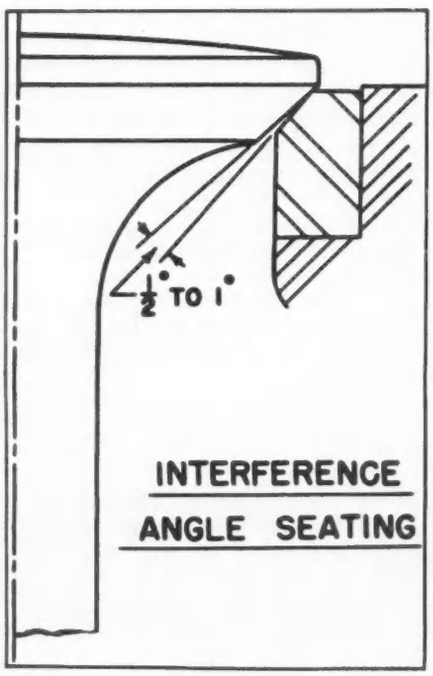


FIGURE 7

Because temperature is a prime factor in the valve failure problem, the most direct approach in alleviating the trouble is by reducing valve temperature. A step in this direction is the use of sodium-cooled valves for heavy-duty engines. Gas engines used as prime movers in pipe line operations have been equipped with sodium-cooled valves with satisfactory results. It should be emphasized, however, that sodium-cooled valves should be recommended only after careful study of the engines in which they are to be used. Sodium-cooled valves result in cooler valve-head temperatures of the order shown in Figure 4.

Port design can play an important role in exhaust valve temperature. Figure 5 is a comparison of good and poor port design for a specific engine. Temperatures shown are actual test results and the improvement realized is substantial which would also be reflected in increased valve life. Non-uniform temperature distribution around the valve seat (Figure 6) can lead to seat distortion and blowby and valve life shortened accordingly.

Valve stem sticking can be alleviated by cutting off valve guides protruding into the ports, thus removing the bearing area where oil and the products of combustion have the greatest tendency for deposit formation. Additional benefit can be obtained by counterboring the valve guide when it does not project into the port area, or by putting a relief in the valve stem. The relief should be .010 inch with sharp edges. Tests have indicated generally that stem deposits of this thickness become brit-

tle and any added thickness will be scraped off the valve stem.

Valve spring pressures should not be allowed to decrease more than 10 percent of the new spring value. Lighter pressures lead to sluggish action with possible sticking and poor seating of the valve when closed. Recommended tappet clearances should be rigidly maintained. With correct tappet clearance, valve train noise will not be too objectionable.

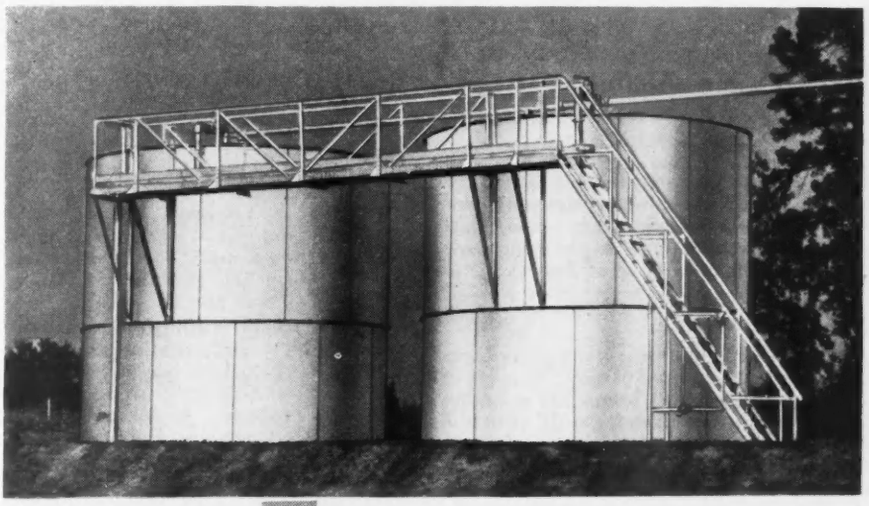
Cooling systems must be kept free of scale to avoid local hot spots in the valve region. Fuel-air ratio and spark adjustment must be controlled to provide proper engine operation and a cool running valve. Where deposition is excessive, fuel and oil should be carefully checked. Some measure of relief may be afforded by the use of an interference angle between the valve face and the valve seat (Figure 7). This expedient tends to dislodge accumulated deposits and retard their formation. Higher unit bearing pressures on the narrow seating surface tend to improve the valve seal.

In general, any step which makes for lower valve temperature will reduce burning tendencies and provide increased valve life.

About the Author

A. L. POMEROY studied mechanical engineering at the Drexel Institute of Technology and the University of Pennsylvania. He joined Thompson Products, Inc., as staff engineer in 1947. He was manager of engineering operations for Ranger Aircraft Engines. Previously, he was associated with the Research and Development department of The Atlantic Refining Company. He is a member of the Society of Automotive Engineers and as chairman of the Aviation Fuels Division is an active member of the Coordinating Research Council. In 1950 he was appointed Director of Development for Thompson Products, the position which he now holds.

Better Fit...Better Protection Assure Longer Tank Life



BUTLER

Bolted Steel OIL TANKS

Butler tanks fit more tightly. Each tank section is formed on precision dies. These precision-made sheets are then accurately punched so that they fit exactly. Thus you get an oil-tight fit throughout the long life of the tank.

Butler tanks have better surface protection. Electrostatic painting puts a uniform coating on all tank parts. Each hole, each edge, each sheet gets a tight, 2-coat paint bond that resists corrosion and rust. They're also available with hot-dipped galvanized coatings and aluminum decks.

Extra care . . . extra skill assure longer life for Butler Bolted Steel Oil Tanks and make them your best long-term investment.

DEPENDABLE SERVICE

from these Butler Distributors

AMERICAN PIPE & SUPPLY COMPANY

Casper, Wyoming — Denver, Colorado — Cut Bank, Montana

HARRY G. MILLER

El Dorado, Arkansas

UNION TANK & SUPPLY COMPANY

Fort Worth, Texas	Tyler, Texas	New Orleans, La.
Houston, Texas	Midland, Texas	Great Bend, Kansas
Odessa, Texas	Nocona, Texas	Tulsa, Okla.
Snyder, Texas	Lafayette, La.	Oklahoma City, Okla.
Alice, Texas	Ruston, La.	Hobbs, New Mexico

These Butler specialists can also give you service or information on
Walkways • Stairways • Unit Heaters • Other Oil Field Equipment

BUTLER MANUFACTURING COMPANY

Kansas City, Mo. Galesburg, Ill. Richmond, Calif. Birmingham, Ala. Minneapolis, Minn.

PIPE LINE *Construction*

By CECIL W. SMITH, WORLD OIL Staff

Projects Announced and Contracts Awarded

Crude Oil Lines

Service Pipe Line Company has announced plans to build 15 miles of four and eight-inch line from Saunders field, Lea County, New Mexico, to the company's Caprock-Slaughter line at Bagtower station.

Products Lines

Gulf Oil Corporation has announced plans to construct approximately 170 miles of ten-inch pipe line from Gulf's Lufkin station in East Texas to El Dorado, Arkansas, and a combination of eight and ten-inch line about 200 miles long between Helena, Arkansas, and Nashville, Tennessee. Work will not start before late 1952.

Imperial Oil, Limited, has plans for a ten and twelve-inch carrier to run from Sarnia, Ontario, to Toronto, via London and Hamilton. This project is scheduled for 1952 construction.

Natural Gas Lines

Associated Natural Gas Company has asked FPC permission to build approximately 88 miles of new line together with town border and distribution regulator stations and other facilities to 14 southeastern Missouri towns. Gas supplies will come from Texas Eastern Transmission's trunk line.

California-Pacific Utility Company has made application to FPC for 14½ miles of four-inch line that the company proposes to lay from Pacific Gas & Electric's main line near Topock, Arizona, to Needles, California. Construction will be underway by July 1 if FPC acts promptly.

Carolina Natural Gas Corporation has been granted authority by FPC to build a total of 67½ miles of line, consisting of two sales laterals each connecting at different places on Transcontinental's main line in North Carolina. They will be known as the Hickory and Lexington laterals.

Cities Service Gas Company petitioned FPC for a permit to lay ten miles of 26-inch line between Welda station, Franklin County, and Ottawa station, Kansas. This would be a replacement for double 16-inch lines now connecting the two stations.

Colorado Interstate Gas Company has awarded a contract to R. H. Fulton & Company, Lubbock, Texas, for the construction of 215 miles of 20-inch line from the West Panhandle gas field of Texas to the company's Lakin-to-Denver line at Kit Carson, Colorado. Starting date has not been announced.

The East Ohio Gas Company has received thumbs up from FPC on its proposal to lay 65 miles of 26-inch pipe line from New York State Natural's planned line at the Ohio-Pennsylvania state line near Petersburg, Ohio, to Twinsburg Township in Summit County, Ohio.

Mississippi River Fuel Corporation received temporary authorization from FPC to build 98 miles of 16 and 18-inch line from Woodlawn gas field, Harrison County, Texas, to The California Company's gasoline plant, Lincoln Parish, Louisiana, and 11 miles of 10-inch from the Waskom gas field, also in Harrison County, to the proposed 16 and 18-inch line. A gathering system in Woodlawn will also be built.

Montana-Dakota Utilities Company received FPC authorization to interconnect its Wyoming gas facilities with those it is authorized to acquire from Billings (Mont.) Gas Company, Big Horn Gas Company, and Rocky Mountain Gas Company by constructing 16 miles of pipe line. The firm will also build a compressor station of 660-hp and dehydration units in Little Buffalo Basin field, Wyoming.

New York State Natural Gas Corporation made application to FPC for permit to lay 35 miles of 20-inch loop and a 6600-hp compressor station at Dryden, N. Y. The loop would run between the proposed station and the Therm City compressor station. The line is not scheduled until 1953, but the station with ½ power would be built this year, with the remaining 3300-hp being added in the following two years.

Northern Gas Company has made application to the Wyoming Public Service Commission for a permit to built an 82-mile six-inch intrastate line from the Sand Draw and Beaver Creek fields of Fremont County, to Rawlins, Wyoming.

Ohio Fuel Gas Company has FPC approval on a proposal to build about 74 miles of high pressure storage project pipe lines ranging in size from 3½ to 20 inches; construct a 47½-mile 20-inch line from Benton Township, Hocking county to Columbus; and install an additional 8480-hp in compressor capacity at existing stations. This project is designed to convert six gas fields into storage pools in Hocking, Knox, and Ashland counties of Ohio.

Pacific Gas & Electric Company applied to FPC for authority to construct 44 miles of eight-inch pipe line from a point south of Salinas, Monterey county, California, to King City, also in Monterey county.

Panhandle Eastern Pipe Line Company has asked the FPC for authority to construct 6½ miles of 26-inch line east of its Houstonio, Missouri, compressor station; a 7.24-mile extension of the 61½-mile segment of 30-inch line east of Zionsville, Indiana; and 18.2 miles of 26-inch line east of the Edgerton, Ind., station. The proposal also includes installation of 2000-hp at Tuscola, Ill., station and 4000-hp at Edgerton.

Public Service Company of North Carolina, Inc., received authorization from FPC to construct a series of five sales lateral systems in North Carolina, four originating at separate connections with Transcontinental's main line, and one connecting with the system of Piedmont Natural Gas Company, Inc. Total length of the system will be about 169 miles.

Southern California Gas Company has awarded the J. E. Young Pipe Line Contractor, Inc., with a contract for 28 miles of ten-inch line to be laid in Ventura county, California. Construction will probably begin sometime in July.

Southern California Gas Company is seeking FPC authorization in order to construct a 35-mile pipe line extending into the Antelope Valley of Southern California. The proposed line would be used to supply natural gas to Mojave, Lancaster, Palmdale and Rosamond, and would bring the gas from the company's existing line near Tehachapi.

Southern Union Gas Company asked the FPC for permission to install ten miles of eight-inch loop line between Clovis and Tucumcari, New Mexico. The proposal also calls for installation of 300-hp on the Clovis-Tucumcari line, and looping of the existing five-inch line from Clovis to Portales.

Southwest Gas Corporation is seeking FPC authorization for 27½ miles of line to run from Pacific Gas & Electric's 34-inch line to Barstow and Victorville, California.

Tennessee Gas Transmission Company has been granted FPC authority to carry out an expansion program to increase its system's capacity 85 million cubic feet daily. Facilities authorized included about 419 miles of 26 and 30-inch loop line along its presently authorized system; 142 miles of 24-inch new line; approximately 200 miles of various diameter along the system; 54,100-hp at existing and previously authorized stations; and 21,120-hp in a new station at an authorized storage project at Hebron field, Potter county, Pennsylvania.

Projects Starting

Crude Oil Lines

Shell Pipe Line Company has started 6½ miles of 4 and 6-inch line from the Pembook field, Upton county, to Shell's Upton station on its main pipe line.

Products Lines

Triangle Pipe Line Company has Anderson Bros. Corporation, Houston, at work on 85 miles of ten-inch line running from El Dorado, Arkansas, to Arkansas City at the Mississippi River. Work got under way about the middle of June.

U. S. Army Engineers have started 190 miles of six-inch pipe line from Searsport, Maine, to the U. S. Air Force base at Limestone, Maine. Associated Pipe Line Contractors, Inc., Houston, has the contract and started construction late in May. W. H. Hinman Corporation, Anson, Maine, has the contract for the ditch.

Natural Gas Lines

Grand Valley Pipeline Company (General Petroleum, M. B. Garman, and Public Service Co. of Colorado) have completed surveys for 105 miles of 8 and 10-inch pipe line that will bring natural gas from the Piceance Creek gas field to communities along the Colorado River including Grand Junction, Colorado, the line's terminus. Actual pipe laying is to start this summer.

Mississippi River Fuel Corporation has started ten miles of 24-inch pipe line between Wood River and Alton, Illinois.

New York State Natural Gas Corporation has started 82½ miles of 20-inch pipe line between Dryden and Utica, New York. Williams-Austin Company, Pittsburgh, has the contract and started laying pipe in June. This leg is about one-half of a 164-mile project to be built from Dryden to Albany. The remaining 81½ miles will be of 16-inch pipe and will also be constructed by the same contractor, and is scheduled for a September start.

New York State Natural Gas Corporation received authorization from FPC and started work on 77 miles of 20-inch transmission line late in May. The transmission line will be laid from the South Bend storage pool in Armstrong and Indiana counties, Pennsylvania, to a connection with East Ohio Gas Co.'s proposed line at the Ohio-Penn State line in Lawrence county, Penna., near Petersburg, Ohio. A total of 17 miles of field lines will be laid by Williams Bros. Company, Tulsa, which is also doing the rest of the project. A 12,000-hp compressor station will be built in the storage field.

Tennessee Gas Transmission Company has Houston Contracting Company, Houston, laying approximately 46 miles of 30-inch line from the vicinity of Galion, Louisiana, south to the vicinity of Iris, Louisiana. This spread started laying pipe June 4th.

Texas Eastern Transmission Corporation has awarded 140 miles of 30-inch pipe line construction to Mahoney Construction Company, Lansing, Michigan, and construction is expected to begin by the end of June. The job is divided into two sections: 100 miles from the Kentucky River to Ohio River, and 40 miles from Uniontown to Connellsville, Pennsylvania.

Texas Illinois Natural Gas Pipeline Company has awarded a contract to Ray L. Smith and Sons, Inc., El Dorado, Kansas, for the construction of 58 miles of 20-inch pipe line to run from Joliet, Illinois, to a connection with Natural Gas Pipeline Co. of America's main line at Volo, Illinois. The job was scheduled to get under way by the first of June.

Projects Completed

Crude Oil Lines

Sinclair Pipe Line Company completed in June a 19-mile stretch of eight-inch pipe line running from Ringling Station to Rubottom station, Oklahoma. Bills & Troth Construction Company, Tulsa, did the job.

Products Lines

Great Lakes Pipe Line Company completed 107 miles of eight-inch pipe line during June. The carrier was laid parallel to the company's main line from Des Moines to Iowa City. A. C. Holder Construction Company, Tulsa, laid the 53 miles from Des Moines to Montezuma and Geneva Construction Company, Aurora, Ill., built the 54 miles from Montezuma to the terminus.

Pure Transportation Company completed 100 miles of six-inch line from Heath to Dayton, Ohio, early in June. Wabash Construction Company was the contractor.

Natural Gas Lines

Canadian Western Natural Gas Company, Limited, completed 22 miles of 12-inch gas line from the Jumping Pound field to Calgary, Alberta, Canada. Another part of the project, 30 miles of eight-inch line to Banff, Alberta, has not yet been completed. Company crews did and will do all the construction.

Cities Service Gas Company completed 30 miles of 16-inch pipe line in Kansas. The line runs from Wichita to Hesston and was laid by Knupp Construction Company, Great Bend, Kansas.

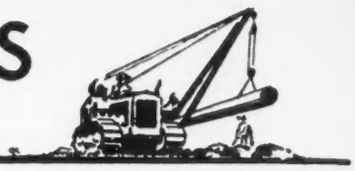
Consolidated Gasoline Company employed Henson Construction Company, Cisco, Texas, to build 10 miles of 2 through 8-inch gathering system in the Bankline field, Eastland county, North Central Texas, connecting the company's gasoline plant. The project was completed early in June.

Dow Chemical Company completed 28 miles of 14-inch, 9 miles of 12-inch, and 10 miles of 4-inch pipe line from Lakeview field, near Pierce, Upper Texas Coast, to Sweeny. Massey Pipe Line Construction Company, Corpus Christi, completed the job late in June.

Trunkline Gas Supply Company was completing 186 miles of 26-inch pipe line from Joppa, Illinois, to Tuscola at the end of June. E. J. Mahoney Contracting Company, Lansing, Michigan, was the contracting firm.

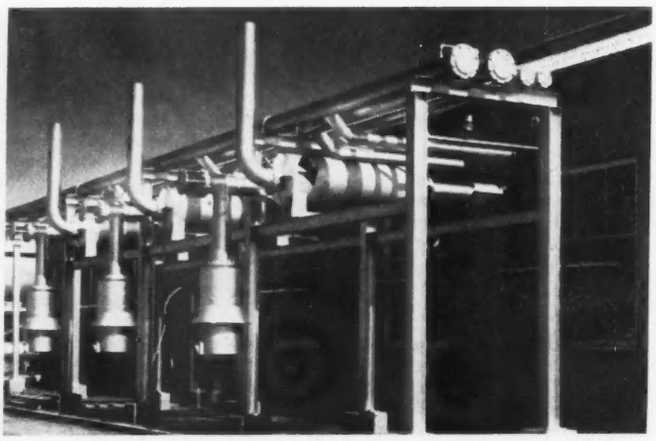
Carrying 20" pipe for installation across the Ouachita River in Louisiana.
HOUSTON CONTRACTING COMPANY
General Contractors
OIL • GAS • GASOLINE • WATER PIPE LINES
LAURENCE H. FAVROT R. P. GREGORY GEO. A. PETERKIN
2707 FERNDALE PLACE HOUSTON 6, TEXAS

How to do it! PIPE LINE HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Compensate Pipe Expansion

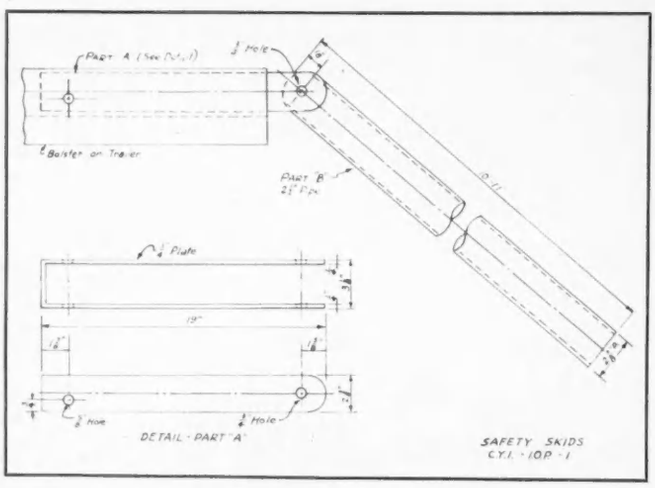


Bearing plates that slide on supports permit silencers and exhaust piping to expand freely when auxiliary engines are started, and to contract when the engines are stopped.

Since the temperatures of the silencer and exhaust piping vary from ambient to as high as 700° F. in a matter of minutes, thus causing as much as one inch expansion in over-all length, it is necessary to allow the piping and silencer to move freely in a linear direction. At the same time, the assembly must be firmly anchored to overcome vibration caused by pulsation of engine exhaust.

The accompanying illustration shows how to solve this problem. An intermediate support welded to the silencer was made from three-eighths-inch plate. The bottom bearing plate of this support rests on the pipe supports outside the auxiliary building as shown. Bolts welded to the structural support extend through a slot in the bearing plate to guide it and to anchor it to the structure. This prevents undue movement of the silencer and piping during operation. No additional support for the exhaust piping is necessary.

HOW TO—Make Simple Safety Skids

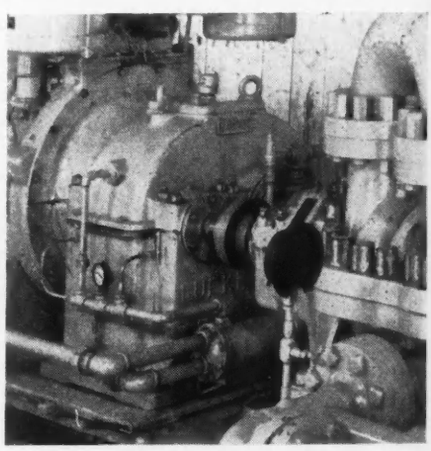


When loading or unloading pipe from a trailer truck there is always a possibility that the skid will slip from the truck or trailer thus creating a dangerous hazard. This can be eliminated by the use of "safety skids" which can be easily and simply constructed.

The skid provides an easier, safer and more efficient method of loading or unloading pipe from a trailer truck to a pipe rack. Referring to accompanying sketch: Part "A" was made of one-fourth-inch plate iron and part "B" from 2½-inch pipe. Only one ¾ x 4-inch machine bolt is needed to fasten the two parts together at point "X." The bolster bumper is then removed from the bolster on the trailer and truck and part "A" is placed in the channel of the bolster. The bolster pin is then used to hold part "A" (at point "Y") in place in the bolster channel. Part "B" will then hinge at point "X" to form the proper grade between rack and truck. By drilling additional three-fourths-inch holes in the 2½-inch pipe to the right of point "X," several additional layers of pipe can be racked on the trailer. Only two of the safety skids are needed for loading or unloading pipe.

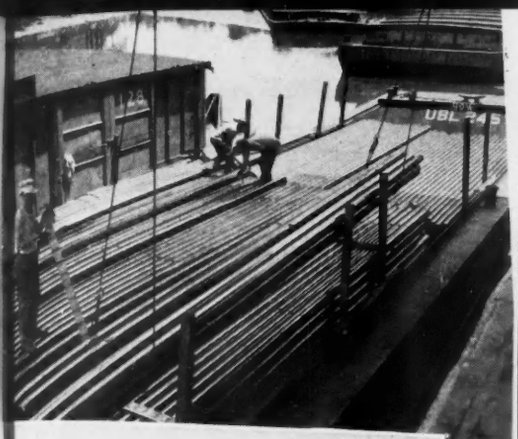
With the safety skid less manpower is needed in loading pipe as it does away with the lifting of the pipe from the skid to the bolster. As much as 25 percent can be saved in the cost of loading and unloading pipe.

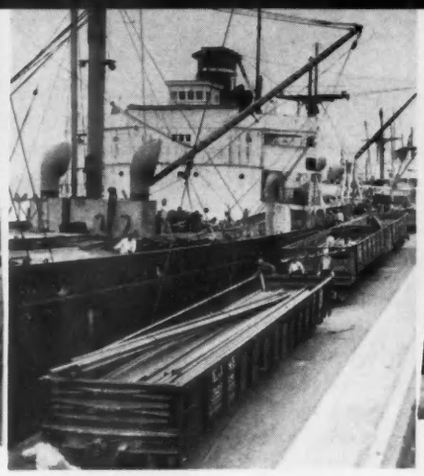
HOW TO— Cool Lubricating Oil In Station Gear Box

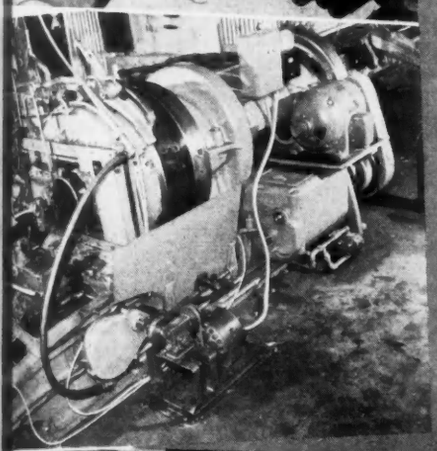


When the temperature of the lube oil in the gear box of a small pipe line pump station rose above safe operating level, a novel means of cooling it with engine jacket water was devised by the operators.

The engine jacket water was piped through the tubes and the lube oil was piped through the shell of a small counterflow heat exchanger. Existing pumps on the installation were used and no additional material other than the piping and heat exchanger were needed to improve the operation.

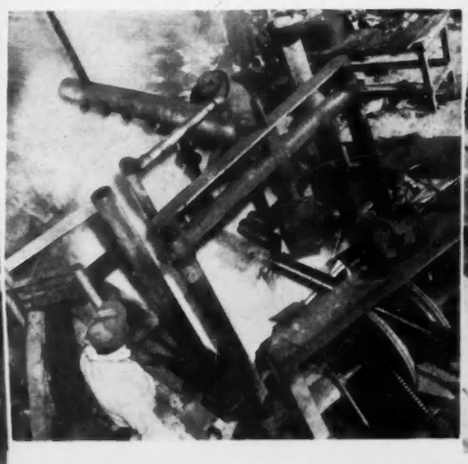




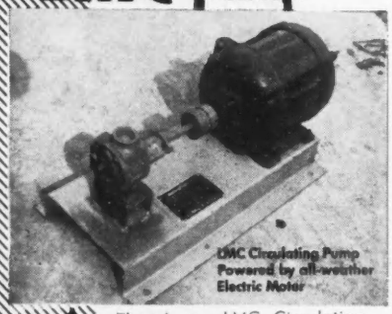


Complete
PIPE SERVICE

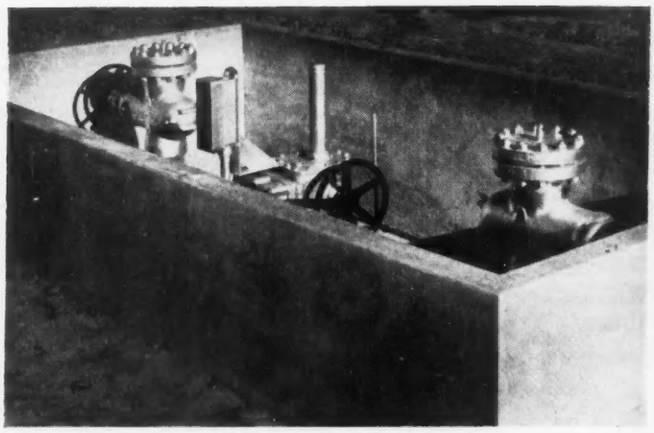
SYD E. CULBERTSON CO.
INC.
5907 Navigation Boulevard
HOUSTON 11, TEXAS



GENERAL
PIPE LINE
CONTRACTORS
Personal Supervision on
Construction of Your
Pipe Lines • Water Lines
Sewer Lines • Excavations
Salt Water Disposals
TROJAN
CONSTRUCTION CO.
INCORPORATED
1416½ N. ROBINSON
OKLA. CITY, OKLA. PH. 2-7696
WAREHOUSE PHONE 6-1430

Another
Circulating
LMC pump

LMC Circulating Pump
Powered by all-weather
Electric Motor
There's an LMC Circulating Pump to save you money on every move from well to consumer. Low initial cost with practically no upkeep cost, plus longer life, mean real economy when you move your oil with an LMC.
LMC PUMPS
At your supply store or
Lubbock Machine Co.
Box 1138, Phone 4631, Lubbock, Tex.

HOW TO—*Provide Valve Drainage*

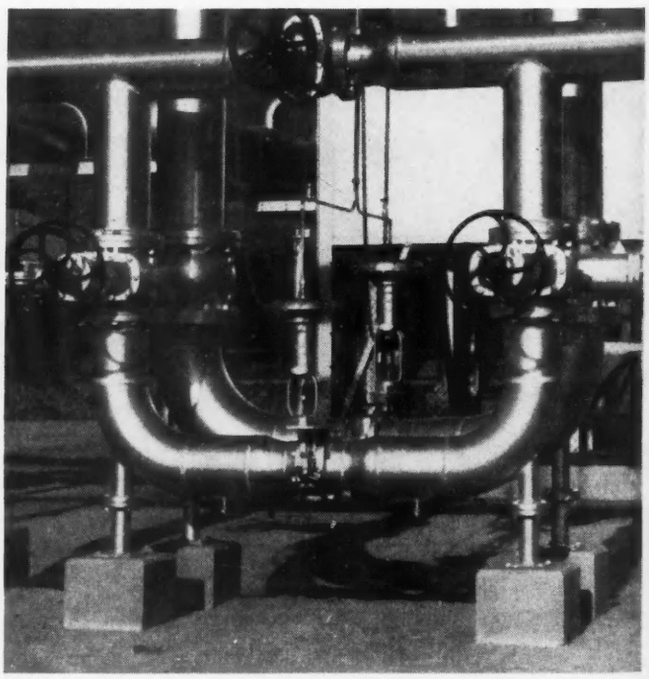


When it was necessary to locate a main line block valve, station suction and discharge valves, and blow-off assemblies in an area that often stood several feet deep in surface water during rainy seasons, Transcontinental Gas Transmission Company built a concrete basin around each valve assembly and provided drains leading to a sump basin, rather than make an expensive earth fill.

The wall of reinforced concrete was poured to about one foot above known flood-water levels. The concrete in the four-inch floor slab was allowed to bone to the valve extension stems and blow-off risers to form a water-tight basin. The concrete slab was swept with a broom during finishing to provide a firm footing during wet weather. The floor was sloped down to a drain located at one end of the basin.

The drains from all the basins were tied to a common drain line leading to a sump that is float switch actuated to keep the basin dry even in the most unfavorable weather.

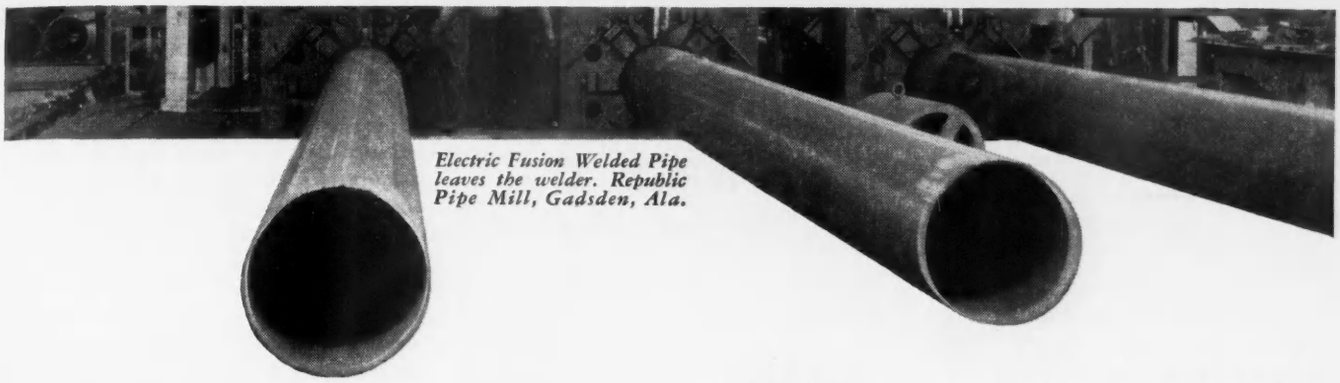
HOW TO—*Support Heavy Assemblies*



Small diameter pipe supports can counteract vibration on heavy control valve assemblies in or near pump stations.

The supports are welded onto the ell at the bottom of the assembly directly in line with the vertical axis of each column. The supports in turn rest on a pier which is topped with a bearing plate of half-inch steel. To provide an easy means of removing the various parts of the assembly during repair operations, each support is flanged in the middle as shown in the illustration. The weld which ties the support to the ell should not penetrate deeply into the pipe metal.

This method can be used throughout a compressor or pump station to provide support for piping installations.



Electric Fusion Welded Pipe leaves the welder. Republic Pipe Mill, Gadsden, Ala.

BIG PIPE *doing a big job...*

It's Republic Expanded Electric Fusion Welded Pipe, now being produced in BIG sizes—24 through 30-inch OD. And, it's doing a big job in helping natural gas move to new nation-wide markets.

This large diameter high pressure line pipe is electric fusion welded inside and out. It is hydraulically expanded to uniform size, straightness and circumference. This hydraulic expansion also increases its yield strength for even safer handling of high pressures.

In every size, this big pipe helps hold field welding costs down. Because its circumference always is constant, field joints line up accurately and quickly. The entire circumference can be welded at top speed . . . lowest cost. Line construction moves fast!

What's more, its uniform wall thickness provides an even distribution of metal which further speeds field welding of circumferential joints.

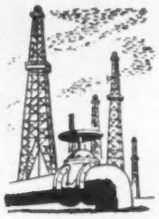
All the facilities of Republic's completely integrated pipe mill at Gadsden, Alabama, are 100% devoted to production of Expanded Electric Fusion Welded Pipe. Republic is doing everything possible to see that the big pipe is ready for its big jobs.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

Another new natural gas line goes in. Crew is applying field coating and wrapping to Republic Expanded Electric Fusion Welded Pipe in Texas.

Republic
REPUBLIC STEEL®
ELECTRIC FUSION WELDED LINE PIPE

TALK OF BEING VITAL...



Trans-Texas brings *exclusive* air service to no less than twenty Texas cities and towns. That means *twenty* communities entirely dependent on Trans-Texas Airways for direct air mail, air freight and air passenger service.

Oil men and other businessmen have come to rely on this service . have come to realize that Trans-Texas *gets you where you want to go* – economically, speedily, comfortably.

For information call Trans-Texas Airways or your travel agent.

TRANS-TEXAS Airways

37th YEAR
SERVING THE OIL FIELD AND ASSOCIATED INDUSTRIES

IF WE DON'T HAVE IT – WE WILL MAKE IT

FIRST-CLASS MACHINE SHOP
■ MODERN MECHANIZED GRAY IRON FOUNDRY

WE SPECIALIZE IN . . .

★ REBUILDING AND TESTING ENGINES • COMPRESSORS AND PUMPS
★ NEW AND REBUILT OIL AND GAS FIELD SUPPLIES AND EQUIPMENT
★ REPAIR AND REPLACEMENT OF ALL INDUSTRIAL EQUIPMENT

SUPPLIES · EQUIPMENT · REPAIRS

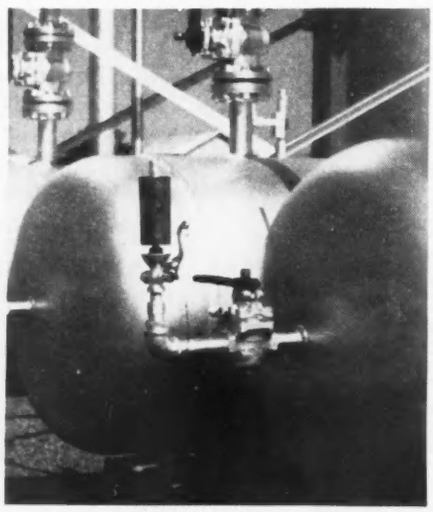
WE *can* FILL YOUR NEEDS

WRITE OR WIRE US, TODAY
PHONES 874 - 875

ACME FOUNDRY & MACHINE CO.
COFFEYVILLE • KANSAS

PIPE LINE HINTS

HOW TO—
Install Whistle On Air Bleedoff Valve



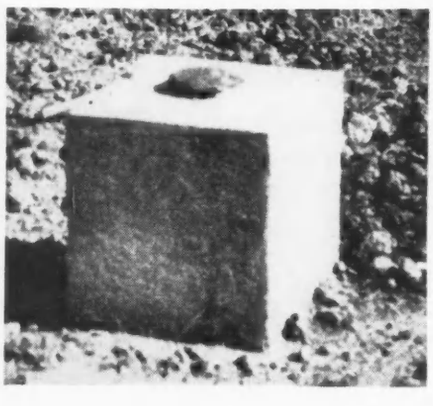
One company provided itself with a useful signal whistle by screwing a one-inch nipple, 90-degree ell and reducer into the end of the bleedoff valve on a starting air receiver.

This whistle, left over from time of construction, has a number of uses around the operating compressor station. It is used to signal key personnel to the office and to signal the start of each shift. When it is necessary to bleed off the air receiver, the whistle can be easily removed.

HOW TO—
Establish Permanent Station Base Line

Sooner or later compressor station or pump station is revised, and engineers are faced with the problem of tying new construction into old.

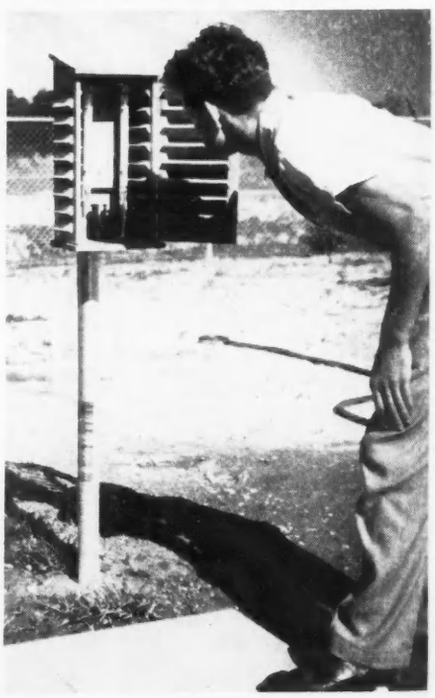
One way to facilitate this tie-in is to establish a permanent base line at the station before original construction starts. This can be done by placing permanent monuments on the base line which should be located far enough from subsequent construction to eliminate the possibility of having the markers disturbed by construction operations. These monuments should not only define the base line but should tie in to station elevation as well.



The monuments are not expensive. They can be made of reinforced concrete, extending well below top soil, formed 12 inches square at the top, and poured "neat" below grade. In top of the marker a bronze or stainless steel plate or disk provides a blank for marking position of the base line.

The base line points are center punched into the plate and if possible coordinates are scratched onto the plate. The elevation and coordinates are noted on the permanent station plot plan.

HOW TO—
House Thermometers In Louvered Shelter



A louvered box provides an answer to the problem of locating the dry and wet bulb thermometers that must be read hourly by station operators.

A "bird house" that protects thermometers from the direct rays of the sun, and from strong winds, yet permits the free circulation of air was made of light wooden materials mounted on a length of two-inch pipe, and set in concrete. The house has louvered sides and front holes in the bottom to provide for free circulation of air and to ward off the sun's rays.

For convenience, the house was located near the office where operators transmit hourly reports

BOOM In Venezuela

AN EXPANDING economy which permits broadening the field of Venezuelan industries has its foundation in the country's sound and lucrative oil business. Other resources—notably iron—are being tapped to supply Venezuela with a diversified industrial development. Meanwhile, petroleum, long the nation's principal source of income, maintains its traditional position as the most important single contributor.

By ROBERT E. SPANN
WORLD OIL Staff

RECORD oil production and a gradual increase in industrial diversification have combined to bolster Venezuela's national economy.

Petroleum exports accounting for more than 90 percent of the total shipments from the country are running ahead of the peak rate established in 1950.

An important new export business —iron ore—was born early this year. National income is being pushed to new highs with continued full employment and fatter pay checks. And under the government's policy of "Sow the Oil," record expenditures are planned over the next few years from petroleum income to further strengthen the economy. These government development plans, aside from purely social improvements, include such significant projects as a proposed steel mill with initial annual productive capacity for 70,000 tons; a 300,000-kilowatt hydro-electric generating plant; complete rehabilitation of railroads; partial financing of new cement-making facilities, and dredging in Lake Maracaibo a deep water channel estimated to cost upwards of $100 million. Three of the major oil companies have agreed to subscribe to $23 million in bonds to help finance the latter.

Probably the most dramatic development in Venezuela this year was the initial shipment in March of 24,000 tons of iron ore to the U. S. Bethlehem Steel Company. Total shipments for 1951 are scheduled at one million tons from the company's El Pao mines in Bolivar state. Bethlehem's shipments are expected to increase in future years, and by 1953 another producer—U. S. Steel Corporation—plans to commence exports from its Cerro Bolivar concession. These reportedly will reach 10 million tons annually at full production. While the start of iron ore shipments culminates the long desire of Venezuela to have a second major dollar-earning export, the productive contribution of this industry for some time will be inconsiderable, compared with oil.

Venezuela's fortune is geared directly to the world-wide need for petroleum. The largest oil-exporting nation, it accounts for about 40 percent of all oil entering international trade and ships about 2½ times as much as its nearest competitor, Iran. The increased demand for oil in 1950 gave Venezuela its biggest trade balance in history. Peak exports for the year, together with a slight reduction in imports, resulted in a favorable trade balance amounting to nearly $600 million, a sharp rise over the post-war low of $232 million in 1949 when demand for petroleum waned.

Early fears of Venezuelan government officials that total exports of petroleum in 1951 might be curtailed as a result of the cancellation of the 1943 U. S.-Mexican trade agreement have been abated, for the time, at least, by continued high oil demand. Ending of this trade agreement means a return to the 1939 trade pact between the U. S. and Venezuela. Under this agreement the amount of Venezuelan crude oil and heavy refined products that can enter the U. S. this year at the 10½ cents a barrel tariff is limited to about 62 million barrels, based on a quota allocated from a formula amounting to 5 percent of the previous year's domestic refinery runs. Venezuela filled its quota on low duty imports during the

TABLE 1
Post-War Petroleum Production Trend in Venezuela

COMPANY	1951*	1950	1949	1948	1947	1946	1945
Creole	738,000	668,184	591,095	635,151	589,442	545,390	452,958
Shell	510,462	461,711	409,983	396,990	331,192	271,852	223,279
Mene Grande	236,065	202,315	169,191	182,131	174,604	158,405	136,352
Socony-Vacuum	46,260	36,907	35,951	30,464	27,798	21,775	11,198
Texas	24,696	25,580	23,357	13,278	8,819	3,477	1,859
Mercedes	22,172	18,706	15,581	6,952	169	173	43
Venezuela Atlantic	20,361	20,944	11,692	3,053	92	78	95
Richmond	12,256	12,502	3,624	765	.....	.....	.....
Sinclair	11,543	12,598	15,190	18,469	21,661	26,818	28,626
Pantepec	10,381	12,318	8,685	.....	.....	.....	.....
Phillips	6,067	7,493	4,855	1,786	370	52	.....
British Controlled Oil	936	995	1,064	1,111	1,157	1,087	1,145
Industry Total	1,659,893	1,497,985	1,321,620	1,338,794	1,191,478	1,064,323	886,036

* Average first four months of 1951.
All figures in barrels daily.

(Source: Ministerio de Minas e Hidrocarburos).

General view of Lagunillas field, looking north, with Creole, Shell and Mene Grande shore installations shown top to bottom. Between the latter two, with its short municipal pier, is the village of Lagunillas. Wells on land belong to Shell, those in a narrow strip offshore to Mene Grande, and those farther out in Lake Maracaibo to Shell.

last week of May and all subsequent shipments carry an import tariff of 21 cents a barrel.

Effect of Higher Duty

It was believed the higher duty would bring some reduction in total exports to the U. S., which last year received 46 percent of the Venezuelan oil shipments. This is not indicated at present, and any cutback in the take of Venezuelan oil by U. S. companies for domestic use will be offset by demand from other areas. With the possibility of a reduction in Western European oil from troubled Iran, there is a real scramble for any available petroleum in international trade.

With Venezuelan oil exporters currently absorbing the extra 10½ cents a barrel U. S. duty to keep their material competitive with prices prevailing on the U. S. East Coast, the Venezuelan government does stand to take a "paper" reduction in its share of oil company profits and from its sales of royalty oil for export to the U. S. With the increased output this year, however, total payments of taxes and royalties to the Venezuelan government are expected to run above the 1950 total, regardless of any possible cut in oil company profit margins.

A longer-range threat to Venezuelan oil exports to the U. S. does exist in an amendment to the reciprocal trade legislation now before Congress. This provides that any industry injured by any imported commodities can demand relief under the law in the form of restrictions on import volume. Under this provision, for example, coal producers could blame possible declining demand on imported fuel oil and seek remedy.

The rise of new industrial development in Venezuela will not diminish the status of petroleum in the national economy, which annually provides about 60 percent of the government's budgetary income. The nation's oil industry now is in the midst of its biggest year. Current Venezuelan production of crude oil is running at a new high of 1.7 million barrels a day, which rate is expected to be the daily average for all of 1951. This would be a 13 percent increase over the daily average of last year. Prompted by the government, refinery capacity in Venezuela is being expanded rapidly and now totals about 475,000 barrels per day. Crude runs to Venezuelan refineries last year were 72 percent over 1949, amounting to nearly 20 percent of crude production. Drilling activity is being pushed vigorously and indications are that total well completions will surpass the record 886 drilled in 1948. The rate of drilling in 1951 generally will be limited only to the availability of oil country tubular goods. Planned capital expenditures of Venezuelan producers have been stepped up, and together with the 10 percent wage hike granted oil workers in a 30-month contract retroactive to last February (adding $30 million to annual payroll costs), will boost total operating costs to a new high.

Drilling Activity

Increased drilling is underway by the large as well as the smaller producers. Creole Petroleum Corporation, largest Venezuelan operator, has budgeted capital expenditures this year of $61 million, up 40 percent over 1950 disbursements. The company plans to drill 143 wells in proven areas and 84 wildcats, more than a 50 percent increase over the 149 completions (53 wildcats) in 1950. Creole presently has seven rigs running on proven locations and six on exploratory structures, with some of the latter stepouts. In eastern Venezuela, Mene Grande Oil Company is running 24 rigs, four of which are on wildcat locations. Mene Grande also has two rigs in the Mara area of western Venezuela. With a range of from 20 to 24 rigs running in 1950, Mene Grande completed 126 wells, eight of which were wildcats. Socony-Vacuum Oil Company, whose current Venezuelan production is nearing 47,000 barrels daily, expects to maintain an average of five rigs in operation in eastern Venezuela, one more than the average of 1950. About 30 percent of Socony's drilling will be in wildcat areas. With the average of four rigs operating in 1950, Socony completed 24 producers in eastern

TABLE 2
Principal Receivers of Venezuelan Petroleum

County or Area	Percent of Total Exports	
	1950	1947
United States	46	39
Canada	8	3
South America	12	13
Europe	22	34
Caribbean	8	6
Others	4	5
Total	100	100

TABLE 3

Oil Industry Employes in Venezuela

YEAR	No. Employed*
1945	26,235
1946	44,585
1947	51,788
1948	61,077
1949	47,116
1950	46,656

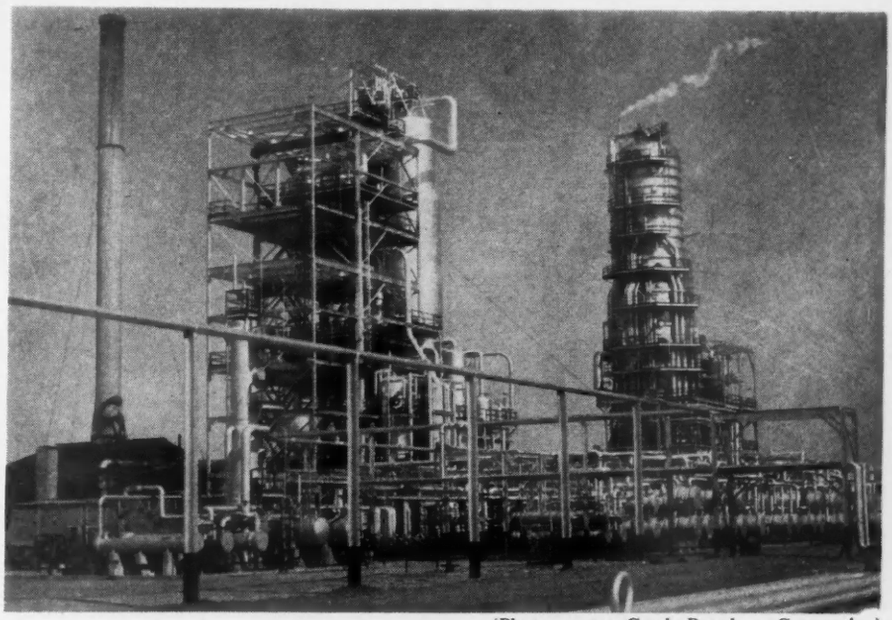
* Average during year.

Venezuela and two wells in the western part. Venezuelan Petroleum Company (Sinclair) plans to keep four rigs going, evenly divided between wildcat and exploitation drilling. The company expects to complete 11 or 12 wells in 1951, depending on material supplies, compared with only two completions (one discovery and one dry hole) in 1950, when only a single rig was running.

New Concessions Foreseen

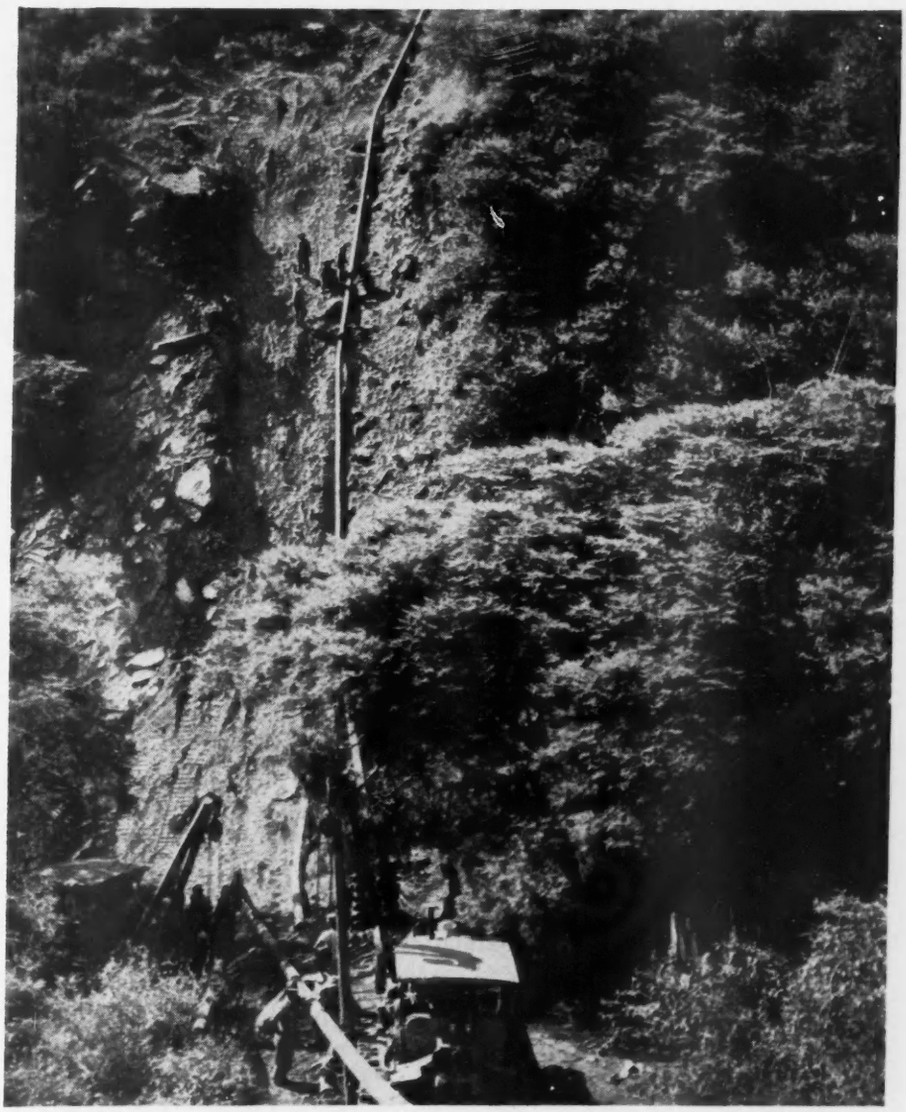
While the operating companies are giving their maximum effort to exploration and development of presently conceded areas, the Venezuelan government for the first time since 1946 reportedly is seriously considering new concession grants. These presumably could be available to present producers and new entries into Venezuela. At least two large American organizations, not producing in Venezuela, are said to be anxious for concessions. While there are still wildcat areas in the present concessions, depending on proffered terms Venezuelan producers for the most part would be interested in the possibility of acquiring additional acreage. A total of 16 million acres, or about one-fifth of the total area considered suitable for oil exploration, is now under concession.

Under the present royalty and tax requirements total payments of each oil company to the Venezuelan government annually must be at least equal to 50 percent of net profits. The actual ratio has been greater than half since these tax laws were instituted in 1943. The profit-limiting provisions create a serious obstacle to possible new companies entering Venezuela. The time required for a new entity to recoup its investment is materially lengthened. A high initial investment would be required, and, according to various estimates, total operating costs in Venezuela currently are as high, if not higher, than similar charges in the U. S. Big volume producer Creole, for example, reports its total costs of finding, producing and marketing Venezuelan crude averages about $1.25 a barrel, while average realization price is around $2 a barrel. A moderate size producer reports it has not yet fully recouped its total investment after nearly 15 years in Venezuela. On the other hand, Venezuela offers the oil producer a relatively high rate of production (averaging 213 barrels per well daily, compared to 13 in the U. S.) and, despite a few interruptions, a record of favorable government-oil company relations.



(Photo courtesy Creole Petroleum Corporation)

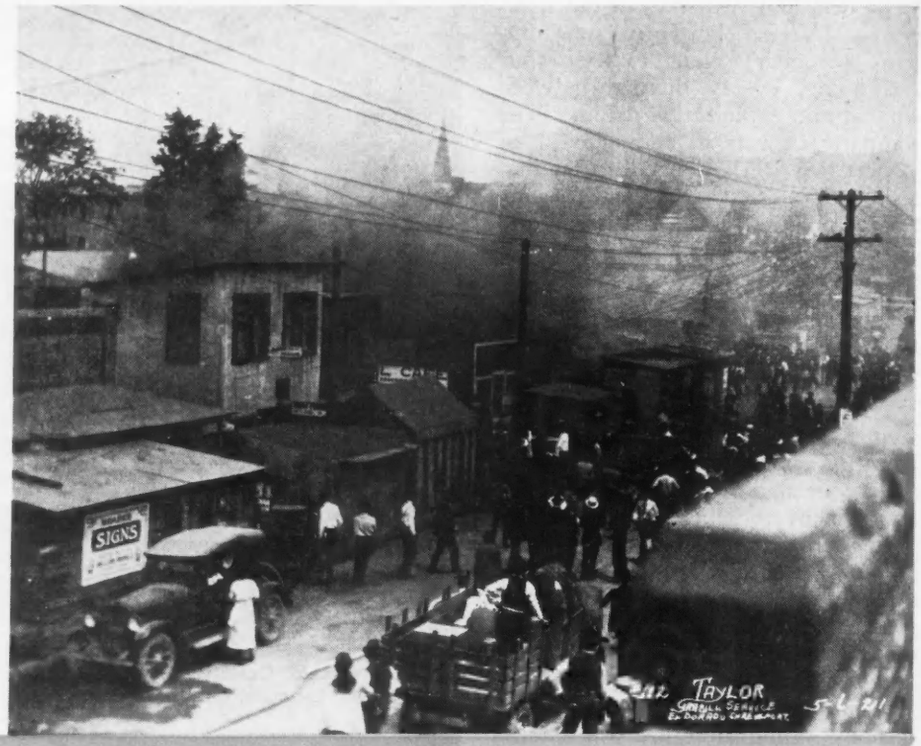
View of Creole Petroleum Corporation's Amuay Bay refinery on the Paraguana Peninsula of northwestern Venezuela. Operations at this plant began in January, 1950, with completion of the atmospheric crude still (left). The vacuum still (right) was completed in August, 1950.



Construction of the Tacagua pipe line, built jointly by Creole Petroleum Corporation and Shell Caribbean Petroleum Company, illustrates the extremely rugged terrain over which the line had to be laid from Catia La Mar on the coast, to Caracas.

KINGDOMS OF OIL

No. 5



EL DORADO, ARK.

Street scene in El Dorado during the oil boom. Gone, today, are the shacks and in their stead stand modern stores and office buildings attesting to the city's progress.

(Photo courtesy Chamber of Commerce, El Dorado)

By ANTHONY GIBBON
WORLD OIL Staff

OIL!

That magic word stampeded thousands of men and women who converged on the tank-town of El Dorado, Arkansas, transforming it overnight into a rough, teeming metropolis, bursting at the seams.

Oil is still the magic word, but the thundering horde has long since moved on to other booms, other triumphs, other sins and other heartbreaks, bequeathing an El Dorado which has grown from a country village of 4000 into a clean, modern, thriving city of 28,000 prosperous, civic-minded people—the oil capital of Arkansas.

The first local newspaper report of the wildcat oil discovery which was El Dorado's boom town birth pangs appeared in the El Dorado *Tribune* of Tuesday, Jan. 11, 1921. It read in part:

"At 4:30 p.m. yesterday the Busey well in 31-17-15, just west of the city limits, blew in with an initial flow estimated at from 10,000 to 30,000 barrels per day. Chal Daniels, Shreveport driller who was in charge of operations, was bailing and had sent the bailer down in the hole six times when it blew in . . ."

Credit for the discovery, Arkansas' first commercial oil well, goes to Dr. Samuel T. Busey, a wildcatter who started his career at Spindletop. Taking what appeared to be an ill-fated wildcat, he drilled it to successful completion. Dr. Busey, now 81 and residing in Rising Sun, Md., where he dovotes his days to research on weed-killers, was honored last October during El Dorado's observance of "Oil Progress Week." Perhaps the high spot in his career was the praise which he received from Admiral of the Fleet Chester W. Nimitz who was in El Dorado for the observance. When the admiral shook his hand Dr. Busey's eyes filled with tears as he listened to the applause of the men and

A SYNONYM for vast riches, El Dorado came by its name honestly with its reservoirs of black gold. Thirty years ago in January, oil was found in Arkansas and the small country town of El Dorado became the state's oil capital—growing into a small cosmopolitan city, rich in legends and future promise. The story of the city's growth through the boom and leavening period makes another interesting saga in WORLD OIL's Kingdoms of Oil series.

women who survived the boom days to make El Dorado a great town.

Others whom El Dorado honors and who are listed as the original unit holders in the syndicate which successfully completed the Armstrong well that cold January afternoon 30 years ago are Anna Crane, L. H. Koon, L. L. Purifoy, A. M. Mayfield, T. J. Gaughan, Mr. and Mrs. J. L. Dykes, Walter George, Chal Daniels, W. E. Patterson, Wong Hing, J. M. Perrine, M. W. Love, H. F. Stewart, C. R. Morgan and Ben Fortson.

Boom in the Mud

While the boom evokes nostalgic memories, El Doradoans live in the present and talk about the old days with tolerant good humor. They recall Pistol Hill, Shooting Valley, and the mud. They will point to the city's busiest intersection and tell you: "There was the deepest mud hole in all Arkansas. More than one mule hauling oil field equipment foundered and drowned before the skinner could take off the harness."

El Dorado today is typical of many Old South towns. The first business section was built "around the courthouse square" and, although the city's commercial life has developed and spread for several blocks in each direction, there is still a crush of business (especially on Saturdays) all around the square. Across from the gleaming stone and marble courthouse which would do credit to a city ten times the size of El Dorado, a few old gaffers can still be seen sunning themselves against the spiked railings of the First National Bank. Some enterprising whittler long since removed a section of the spikes so he and his cronies could sit down without getting stabbed.

El Dorado, served by the Rock Island and the Missouri Pacific, is an important trade center. It is about 100 miles from Shreveport and the same distance from Texarkana. Pine Bluff and Little Rock are about 125 miles away. Interchange of commerce between these thriving cities and El Dorado is constant and impressive.

Small business thrives alongside big business and little labor unrest has been experienced. Prices, however, are somewhat higher than in nearby sections but El Doradoans gladly pay them and attribute the cause to the fact that business is good and merchandise has a ready demand.

The steady demand for merchandise seems to be a continuation of the city's early boom days. John H. Vogel, assistant manager of El Dorado's two daily newspapers, the El Dorado *News* and the El Dorado *Times*, recalls that many a merchant got rich without dabbling in oil.

"Any one with a small store or a hole-in-the-wall during the early boom days sold out his entire stock about once a week. Trucks and carloads of merchandise poured into the city from Dallas, Little Rock and as far south as New Orleans, to replenish the shelves. And," he added, "it wasn't shoddy stuff. It was merchandise." Apparently the momentum continues.

El Dorado boasts its share of modern and imposing public buildings. Besides its $400,000 courthouse erected in 1927 to serve Union County, there is the magnificent Federal Building, completed in 1931 and costing $400,000. It was built with an eye to the future and in addition to an efficient post office department, it houses many of the various new government agencies and bureaus. Postal receipts are in the neighborhood of $200,000 annually.

Other El Dorado milestones of progress include the imposing Municipal Building, built in 1927, at a cost of $125,000; the American Legion Community Center at Bodenhamer

Courtesy Chamber of Commerce, El Dorado

It was a gusher such as this that jolted tanktown El Dorado out of its simple village ways and made it one of the nation's great oil producers.

Memorial Park. It was completed in 1948 at a cost of $75,000, raised by popular subscription. Its banquet hall will seat 500. Also at Bodenhamer Park is Memorial Stadium, a new addition to the Public School system, completed in 1946 at a cost of $200,000 with seating capacity for 8000.

Dominating the skyline is The Lion Oil Company's headquarters, an eight-story structure which houses the 500 or more office employes of The Lion Oil Company and Lion Chemical Company, one of the fastest growing independent oil companies in the nation.

El Doradoans are God-fearing citizens and have over 30 fine churches representing almost every religious denomination. A conservative estimate of El Dorado's church properties runs well over $2 million.

A large hospital, one 85-bed clinic and a new 30-bed clinic provide adequate facilities for the sick. El Dorado citizens in 1949 subscribed $450,000 for expansion of the hospital. Sisters of Mercy contributed another $300,000. Eligible from the federal government is another $350,000, or a total of $1¼ million. El Dorado promises to become the hospital center for all of South Arkansas and North Louisiana.

While stately old Colonial style homes, symbolic of the Old South, may be found in every section of the city, El Dorado's housing problem is very real. Home building continues at an accelerated pace, but not fast enough to keep up with the influx of population. More than 200 building permits for new residences inside the city were issued last year, but current restrictions on credit and building materials resulting from defense efforts pose a real problem for the home owner.

Courtesy Chamber of Commerce, El Dorado

Back in El Dorado's boom days this was "Hamburger Row," typical of the hastily constructed shanties which sprang up overnight to meet the needs of frenzied fortune seekers.

Since the war the city's spectacular growth is due, in large measure, to the rapid expansion of Lion's huge chemical plant. Located five miles north of El Dorado, the plant is one of the country's most modern petrochemical units producing about 130,000 tons of nitrogen annually and with a manufacturing area covering approximately 128 acres. Anhydrous ammonia, aqua ammonia, nitric acid, nitrogen solutions and ammonium nitrate fertilizer are produced from natural gas, air and water. About 40 million cubic feet of natural gas are used daily as raw material and fuel. A sulfuric acid plant which began operation in the late summer of 1949 has a daily capacity of 300 tons. At capacity operation the 300 tons of acid can be used with anhydrous ammonia in Lion's new sulfate of ammonia plant to produce 380 tons of sulfate of ammonia per day. This chemical plant produces approximately 10 percent of the nation's commercial output of synthetic nitrogen.

Proud of their achievements, El Doradoans are also lavish in their praise for the men whose genius and efforts have made their town. The roster is long and contains such names as Dr. Busey, C. H. Murphy and his son, C. H. Murphy, Jr., H. L. Hunt, Col. T. H. Barton.

The Colonel and Chemicals

Credit for obtaining the chemical plant for El Dorado goes to Colonel Barton, who took over Lion Oil Company more than 20 years ago when it was a small "tea kettle" refinery with some production, one wholesale plant and three filling stations, and built it into an organization that is today the largest industrial enterprise in Arkansas. The chemical plant was built by the government during World War II after Colonel Barton persuaded officials that El Dorado was the logical location. It was operated by Lion from its inception and the company acquired it, lock, stock and barrel in 1948. Today, Lion is the largest individual shipper on any railroad in Arkansas. Lion's purchases amount to $38 million a year and it pays about $21 million to Arkansas property owners and producers for crude oil. The company is also one of the largest direct and indirect taxpayers in the South with a tax bill of approximately $12 million annually.

Pan-Am Southern Corporation's refinery, formerly Root Petroleum Company at El Dorado, has a daily capacity of 25,000 barrels of crude oil. This company is completing a multi-million dollar expansion program consisting of construction of a coking unit and a new catalytic cracker.

Two more refineries in the El Dorado area, owned by MacMillan Pe-

Courtesy Chamber of Commerce, El Dorado

Aerial view of the heart of El Dorado, progressive "Oil Capital of Arkansas."

Dr. Samuel T. Busey, left, "daddy" of the El Dorado discovery, shakes hands with Admiral of the Fleet Chester W. Nimitz during "Oil Progress Week" observances at El Dorado. O. C. Bailey, chairman of the Arkansas Oil and Gas Commission, is an interested on-looker.

Col. T. H. Barton—"Mr. El Dorado" himself—who, fellow townsmen assert, has done more than any other toward the prosperity and civic improvement of the city. About 4000 attended the colonel's last birthday party, where he is shown sharing his birthday cake with the kids.

troleum Corporation and H. H. Cross Company, respectively, are in continual operation, as are more than a score of production companies and subsidiary businesses such as supply houses, machine shops, etc.

El Dorado is an industrial city with low cost natural gas fuel, extraordinarily pure water and plenty of electric power. It is the center of an area that in 1949 produced 29,666,355 barrels of crude oil worth about $73 million.

Other Industries

Overshadowed by oil, but by no means insignificant in El Dorado's industrial picture, is the lumber industry which supports 30-odd sawmills in Union County where soft white pine grows in abundance. Also to be found are gum, oak, hickory and cypress.

Other industrial activities include bottling plants, fish lure factory, brick plants, block plants, fertilizer factory, etc.

Shopping facilities in El Dorado equal those available in cities trebble the size and retail sales in 1949 were over $43 million.

El Doradoans are not only proud of their city but they have a down-to-earth affection for it. This feeling is well described by R. C. Bodenhamer, an insurance man: "The heart and backbone of El Dorado is its oil and gas and the giant petroleum and chemical industries that have grown around these natural resources. Then, too, we are in the heart of some of Arkansas' best timber country, while agriculture, another basic industry, contributes to our general economic welfare.

"Statistics show that our working people enjoy the highest average earnings per employe in the entire state. El Dorado folks live well. But, let me hasten to state, money is not all we think about here in the Oil Capital of Arkansas. We admit we're fortunate in a financial sort of way, but we're not snooty about it. In fact, we're just a bunch of old country boys who like to stand around and chew the fat about every-day things that country boys anywhere like to talk about. We take hunting and fishing seriously—and there we're fortunate again. All around us are big woods and wide fields where squirrel, fox, deer, turkey, quail and other game abound. We have, almost in our back yards, many of the finest fishing lakes in the South, where bass, crappie, bream and other members of the finny tribe dwell beneath the cool waters.

"We take great personal pride in our schools and churches. We go in for the cultural side, but we also hang on doggedly to our predilection for hill-billy music as played on the old "gittar" and fiddle. We still prefer corn bread, cold coon and collards to caviar. But on the sophisticated side we have one of the swankiest country clubs you ever saw. In matters of civic interest we all pitch in, particularly in matters concerning the education and training of our youth. We get a lot of satisfaction in the knowledge that when our boys and girls grow up they won't have to go elsewhere to find their opportunity to make a start in life. We older citizens can look way down the road and see ever-increasing opportunities because El Dorado is just beginning to really grow.

"Believe me, I do like it here; and so do all the other folks who call El Dorado home."

ACKNOWLEDGMENT

Thanks to *The Lion Oil News* staff, the El Dorado Chamber of Commerce, the El Dorado *News-Times*, *Prudential Mirror* and other El Doradoans who furnished data and pictures.

Courtesy Lion Oil Company

Modern stores have replaced the shanties in El Dorado. A view on the north side of the courthouse square looking west on Elm Street. Lion Oil Company's eight-story headquarters building is in center.

Failure of Iran Talks Perils Supply-Demand Balance

ABRUPT termination of Iran's oil talks last month maintained the threat to the delicate balance between world crude supply and demand.

The British government mission, called home when Iran flatly refused to negotiate on the basis of any proposal counter to the Nationalists' demand for outright control of the extensive Anglo-Iranian Oil Company enterprise, left facilities in the hands of Iranians.

Premier Mossadegh won a new vote of confidence from the Parliament, thus erasing hopes that the legislators were cooling toward the premier's campaign to drive the British-owned company from Iran.

Rioting crowds roamed Teheran's streets; the company's offices were invaded; AIOC signs torn down and Iranian flags were hoisted in their place. No serious damage to the offices was reported, but the British embassy said a protest would be lodged against police for failing to halt the holiday-spirit demonstrations.

The U. S. is reportedly convinced that nationalization of the Iranian petroleum industry will bring about dwindling production and that economic and perhaps political disorder will follow. Most of Iran's revenue has come from AIOC royalties. If Iran fails in the oil business, the U. S. would be pressed in making up the loss to save the country from falling prey to Russian communism.

It has been reported that American oil companies may pool their overseas facilities to help meet any oil shortage resulting from this crisis. Government officials said the Petroleum Administration for Defense has asked the Justice Department for a waiver on the antitrust laws so the joint effort would be legal.

Most seriously affected by even a temporary slowdown of Iran's production would be Great Britain and Western Europe, which depend on Iran for upwards of 350,000 barrels daily to fill petroleum requirements.

Both worldwide crude and refinery production this year have reached new highs, but so has demand for petroleum. Currently there is no excess crude production available to transportation facilities in the quantity to entirely offset temporary loss of Iranian production which through May averaged 650,000 barrels daily. Even though some available productive capacity exists—for the most part approximately 400,000 barrels daily in the U. S.—present refinery production throughout the world is at, or near, total capacity. Refineries in the U. S. are running at 93 percent of theoretical capacity, and considering close-down time for maintenance and repairs, the actual rate allows for little, if any, additional crude processing.

Vital to Europe

Any curtailment of production of Iran's two plants at Abadan and Kermanshah, with total capacity for 550,000 barrels daily, would result in near total loss of that amount of petroleum products to world supply channels. While this amount is less than 5 percent of total world consumption, now approaching a rate of 12 million barrels daily, it is the major source of supply to European nations as well as a sizable portion of Asia and North Africa. Logistic complexities would not permit diversion of half a million barrels a day of refinery production from other areas to fill such a vacuum created even if this quantity were readily available.

The long-range possibilities of offsetting loss of sharp curtailment in the flow of Iranian oil is more promising elsewhere. World production is increasing and refinery capacity is being added rapidly, though much of the latter now under construction will not be completed until the second and third quarters of 1952. Should demand continue its present rate of increase—exclusive of a world military conflict—the problem of long-term replacement of Iranian oil would be nearly as severe as the immediate outlook.

Of the world areas producing petroleum in excess of domestic demand, the Middle East, with fast mounting production, is the best source for supplying additional crude as to availability and location to overseas transportation. While no estimates are available on the future producing rate of the Middle East, the current rate of increase over 1950 offers some indication of the area's productive possibilities. The region's output from the fields of Saudi Arabia, Kuwait, Iraq, Qatar and Bahrein—exclusive of Iran—now averages about 1½ million barrels a day, up 400,000 barrels daily more than a year earlier, and within 300,000 barrels a day of the production of the Middle East—including Iran—in 1950.

Iran, which has had a gradual decline in production since February as nationalization and accompanying internal disorder had their effects, was replaced by Saudi Arabia as the largest Middle East crude producing nation in April. Daily average output by Arabian American Oil Company increased to 739,780 barrels in May, up from an average of 550,910 barrels a day in the like month of 1950. Aramco's average for all of 1951 is expected to run about 700,000 barrels daily, which would compare with 548,800 barrels a day in 1950. Production by Kuwait Oil Company, which has increased sharply to major status during the last four years, now averages around 510,000 barrels daily, a jump of 65 percent over a year previous. Iraq, where production will be expanded greatly by 1953 with completion of new pipe line facilities, currently is producing at the rate of 173,000 barrels a day, up about 52 percent over the corresponding period of 1950. Production from Qatar now is running at a rate of 50,000 barrels daily, compared with 30,000 barrels a day in 1950. Only Bahrein, with 1951 output averaging about 30,500 barrels daily, has not shown any increase over 1950.

"You say I'll get more information with

LANE WELLS

Radioactivity

WELL LOGGING"

OK - tell me why!

All right — here's why. There are four good reasons. First, there's *curve quality*. That means curves which faithfully record every formation change of any significance. Lane-Wells assures you these accurate, dependable curves through *advanced equipment* — instruments sensitive to every significant down-hole variation, instruments carefully calibrated to produce highly repeatable responses. Then, you have *accurate depth measurements*. You know the importance of those, and you know, too, that Lane-Wells measurement accuracy is tops in the field. And finally, you know the vital importance of *operating experience*. Lane-Wells has run more than 36,000 radioactivity well logs; Lane-Wells men know the problems of practically every active oil field. That experience can be a great help to you on your job, particularly in the matter of interpretation where local conditions produce unusual responses.

Add them all together — equipment, accuracy and experience — and what do you have? Better results with Lane-Wells Radioactivity Well Logging.

Tomorrow's Tools - Today!

ASK YOUR LANE-WELLS MAN!

General Offices, Export Office and Plant • 5610 So. Soto St. Los Angeles 58, California

Los Angeles • Houston • Oklahoma City
Lane-Wells Canadian Co. in Canada
Petro-Tech Service Co. in Venezuela

AR-406

Of World Oil Men

W. S. S. RODGERS has been elected chairman of the board of Arabian American Oil Company, succeeding H. D. Collier, who has served as chairman since 1940. Rodgers, who has been associated with Aramco since the company was formed, is chairman of the board of The Texas Company, having served in this capacity since 1944. He joined Texaco in 1915 and was elected president in 1933.

W. S. S. Rodgers

R. G. Follis

W. F. Moore

Collier started his career with Standard Oil Company of California in 1903 and now is a director and chairman of the finance committee of that company. He has served as chairman and president of California Standard and will continue as a director of Aramco and its subsidiary, Trans-Arabian Pipe Line Company.

Rodgers is being succeeded in his former position as chairman of the board of Trans-Arabian Pipe Line by R. G. Follis, previously vice chairman. Follis, who has been with California Standard since 1924, is chairman of the board of that company. W. F. Moore, president of Arabian American, has been elected a director of Tapline and a member of the company's executive committee.

R. G. (DICK) REESE, chief of exploration for Arctic Contractors, has joined Hudson's Bay Oil and Gas Company, Ltd., as chief geologist, R. C. Brown, vice president, announced at Calgary, Alberta.

Hudson's Bay Oil and Gas Company, Ltd., is the operating affiliate in Canada of Continental Oil Company.

Reese served with Arctic Contractors for the past year and a half, exploring and developing the U. S. Navy Petroleum Reserve in the Point Barrow region of northern Alaska.

JOHN R. BEVERLEY, acting manager of the department of industrial relations of the International Petroleum Company, Ltd., with headquarters in Lima, Peru, has been appointed to the company's board of directors, Paul W. Lambright, International Petroleum general manager, announced.

MILLARD K. NEPTUNE of Washington, D. C., has been elected president of the Platte Pipe Line Company, which was organized by British American Oil Company, Ltd., of Toronto, Ontario, and four major U. S. oil companies to construct and operate a 20-inch crude pipe line extending from the Rocky Mountain-Wyoming fields to the Wood River area in St. Louis, Ill.

Millard K. Neptune

Neptune, who succeeds Henry L. Phillips, vice president and director of Sinclair Oil Corporation, is a veteran oil man who served as assistant director of production for the U. S. Petroleum Administration for Defense prior to joining the Platte Pipe Line Company. A graduate of the University of Oklahoma Law School and College of Engineering, he also spent a number of years supervising operations for the Phillips Petroleum Company in Venezuela.

P. W. PARKER, who has been chairman of the board of the Standard-Vacuum Oil Company, in York since 1946, has been elected president of the organization, a post which he held from 1934 to 1946.

L. V. Collings, general counsel, resigned as a vice president to become chairman of the board. H. W. McCobb, also a director, was elected a vice president.

An executive committee, recently organized and headed by Parker, with Vice President H. F. Prioleau as vice chairman, is empowered to function between board meetings.

Edward N. Leibacher and George F. James were elected directors, one to fill a vacancy created when L. W. Elliott, former president, resigned recently to become a director of Standard Oil Company (N.J.). The other increased Stanvac's board membership from nine to ten. Leibacher has been coordinator at New York for the organization's interests in Indonesia. James has been treasurer, and will be succeeded by Harold Midtho, former assistant treasurer.

E. E. BARBERII, professor of petroleum production at the University of Tulsa, has taken a temporary assignment with Petroleos Mexicanos in Mexico City as advisor of production techniques for Pemex, the Mexican government's oil monopoly.

Professor Barberii is a native of Venezuela and for some years was with Creole Petroleum Company.

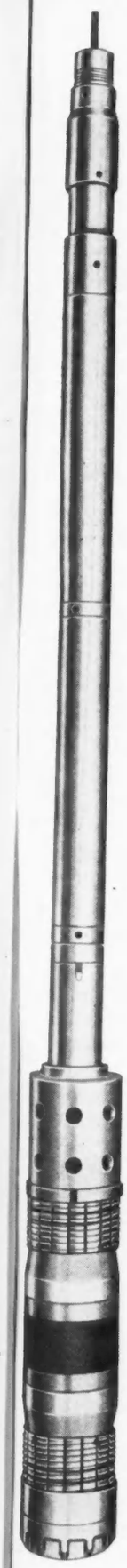
While in Mexico, he will be associated with Ing. Alfonso Barnetche and Ing. Francisco Inguanzo, manager and assistant manager, respectively, of Petroleos Mexicanos. It is expected he will be called upon to make a special study of production problems in the Poza Rica field, Mexico's leading producing area, as well as surveys of recent oil discoveries in other parts of the Republic.

Professor Barberii plans to rejoin the faculty of the University of Tulsa in the fall.

DR. CLAUDE E. ZoBELL of The Scripps Institution of Oceanography, La Jolla, Calif., a consultant and researcher on problems of petroleum microbiology, is on an extensive tour abroad. For several weeks he participated in the "Galathea" Deep Sea Expedition, collecting sediment samples from the deepest parts of the ocean between Japan and Australasia. He presented a paper before the Third World Petroleum Congress at The Hague and also had conferences in Rome, Naples, Cairo, Calcutta and Manila. The expedition is sponsored jointly by the U. S. Office of Naval Research, University of California, and Royal Danish Navy.

Dr. C. E. ZoBell

Successful Tools on a Wire Line



When you select a Bridge Plug, it will pay you to choose the only one that is backed by more than 10,000 successful runs—at every depth—and for every known type of subsequent operation. The Baker Model "K" Retainer Bridge Plug (Product No. 400) is an adaptation of the Baker Cement Retainer, which is too well known to all operators to require any explanation or comment.

In addition to *knowing* that you have selected the most successful Bridge Plug ever developed, you can choose the type exactly suited to your needs: The Cast Iron Type for permanent installations; the Magnesium Alloy Type for temporary service.

Regardless of the size or type of Baker Bridge Plug selected, it will *always* drill out *quickly* and *easily* because *all* Baker Bridge Plugs are *designed* and *constructed* with "drillability" in mind. The very minimum cross-section of material need be drilled up, and even the slips are segmented to break up readily.

You won't need to place cement above a Baker Bridge Plug to obtain a 100% leak-proof pack-off, but you'll be able to place cement there very simply if you desire with the Baker Model "B" Dump Bailer, which is run on a wire line at the same time as the Bridge Plug, when the wire line setting method is used.

After the Baker Bridge Plug is set you can safely proceed with any future operations because it will withstand any pressures you dare impose upon the casing—remain permanently in position—and drill out with no difficulty in record time—every time.

CAN BE SET ON TUBING OR A WIRE LINE

The Baker Retainer Bridge Plug can also be run and set on tubing—as thousands have been installed through the years—but to save wear and tear on tubular goods, as well as to save time on deeper settings, any of the leading service organizations listed below can run and set Baker Bridge Plugs on electrical conductor cables. Ask your service company for details—they will give you every cooperation.

BAKER MODEL "K" RETAINER BRIDGE PLUG PRODUCT NO. 400-D

FOR WIRE LINE SETTING CALL

Byron Jackson Co. • Dowell, Inc. • International Cementers, Inc. Lane-Wells Company • McCullough Tool Co. • Perforating Guns Atlas Corp. • Schlumberger Well Surveying Corp. • Welex Jet Services, Inc. • Well Perforators, Inc. • The Western Company

Baker Retainer Bridge Plug

Gas Ruling May Slow Canadian Activity

DRILLING and producing operations in parts of Western Canada could be hindered by possible litigation resulting from a decision of the Supreme Court of Alberta which upheld a landowner's claim to subsoil gas.

The ruling was made in a case brought by an Alberta farmer who had purchased land in the Leduc area from Canadian Pacific Railway Company on which the latter reserved rights to subsoil deposits of coal, petroleum and valuable stone. Imperial Oil, Ltd., obtained a development lease from the railroad and commenced drilling. The landowner then sued on the ground that natural gas was not specifically reserved in the sale of the land by Canadian Pacific and his claim was upheld by the court. Imperial and Canadian Pacific were permanently enjoined from using, removing, wasting, interfering and otherwise disposing" of any natural gas that may be produced incident to petroleum. Such a reservation on gas, in effect, would make it impossible to produce oil.

While it has been indicated the ruling may be appealed, considerable acreage in Alberta has been sold by the large original land owners reserving mineral rights. The Alberta court's decision could pave the way for claims and possible suits of other purchasers where no specific reservation was made to natural gas by the seller. In cases where present surface owners' rights to natural gas may be upheld, it is presumable that claims could be made for compensation based on previous production. This possibility could have the effect of curtailing drilling in Alberta on acreage where ownership of subsurface minerals could be disputed.

Compared to the total area of major oil-producing Alberta province, the acreage that could possibly be involved in such litigation is relatively small, but a large part of it is in the Leduc area. All subsoil rights (including gas) have been reserved to the Crown, meaning for all practical purposes the government of Alberta, on all lands granted to settlers since October 31, 1887, unless mineral rights were specifically conveyed in land patents issued. The government has full mineral rights on approximately 147 million of the total area of 163 million acres in Alberta. Subsurface mineral rights on the remaining 16 million "freehold" acres belong to large landholding companies such as Canadian Pacific and Hudson's Bay Company, and to a minor extent the small individual owners where original grants were received prior to the fall of 1887.

Canadian Pacific alone originally was patented 9,807,000 acres on which mineral rights were conveyed by the Crown, and total holdings by this company and other large grantees amount to more than 13 million acres in Alberta, or about 80 percent of the freehold total. The question of exact rights reserved could arise on previous sales of such freehold lands by the large holding companies. Most of the freehold acreage lies in the older settled parts of Alberta.

ASK THE ROYAL ABOUT CANADA'S OIL

Branches throughout Canada's oil-rich western plains. On-the-spot information available through J. C. Mayne, Supervisor, Calgary, Alberta, or Head Office, Montreal

Assets exceed $2,497,000,000

We do not provide information on oil securities

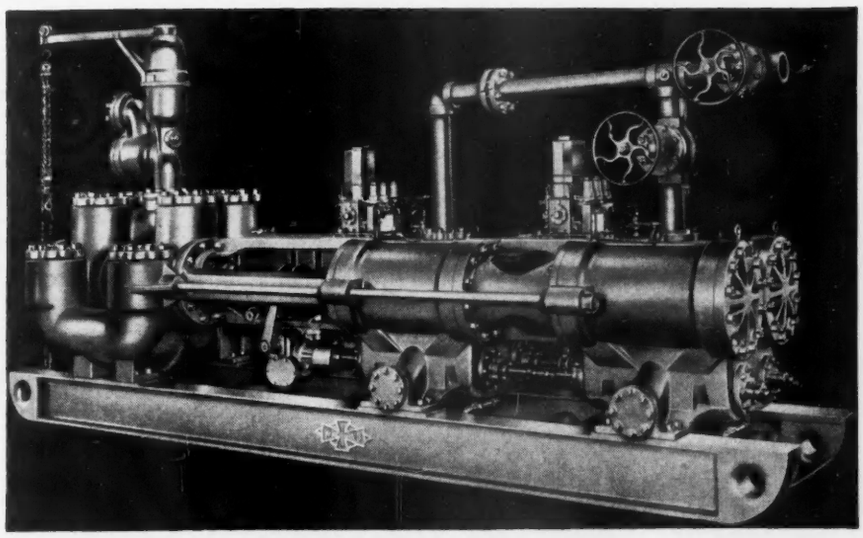
THE ROYAL BANK OF CANADA

Over 750 branches in Canada and abroad

the WHELAND
QUAD STEAM PUMP

H-20000-BAB 16½" x 16½" x 20" – 8", 7½", 7"

- **Eliminates compounding troubles**
- **Either one or both steam cylinders may be used as desired**
- **More economical than two separate pumps**



- **Equivalent to a two cylinder duplex pump with cylinders 23-5/16" bore**
- **Steam horsepower equivalent of two 16½" x 20" x 8" pumps**
- **2,875 lb. mud pressure at 300 lb. steam with 8" liners**
- **9.584 to 1 steam to water ratio with 8" liners**
- **Liners need changing less frequently**
- **"Upside down" steam ends, patented**
- **Net weight only 32,800 lbs., with skids**

Here's a pump with all the "guts" for big steam rigs. The specifications below tell its story, and each day the units in operation demonstrate the efficiency and values of WHELAND H-20000-BAB QUAD PUMP.

H-20000-BAB WHELAND QUAD STEAM PUMP SPECIFICATIONS

Steam cylinders	16½" and 16½" x 20"
Hydrostatic test on steam cylinders	700 P.S.I.
Steam pressure, maximum working pressure	350 P.S.I.
Speed, normal R.P.M. each side	50
Steam pipe size to each cylinder	4"
Exhaust pipe size from each cylinder	4"
Main cylinder, piston rod diameter	3¾"
Auxiliary cylinder, piston rod diameter	3¼"
Water piston rod diameter	3⅛"
Water piston rod fitted for No. 6 A.P.I. piston tie rods, diameter	2¼"

FLUID END

Material, solid one piece steel casting	
Hydrostatic tested, discharge ports to	6000 P.S.I.
Hydrostatic tested, suction ports to	3000 P.S.I.
Maximum working pressure recommended	3000 P.S.I.
Discharge pipe, standard size	4"
Suction pipe, standard size	10"

COMPLETE MECHANICAL DETAILS ON REQUEST

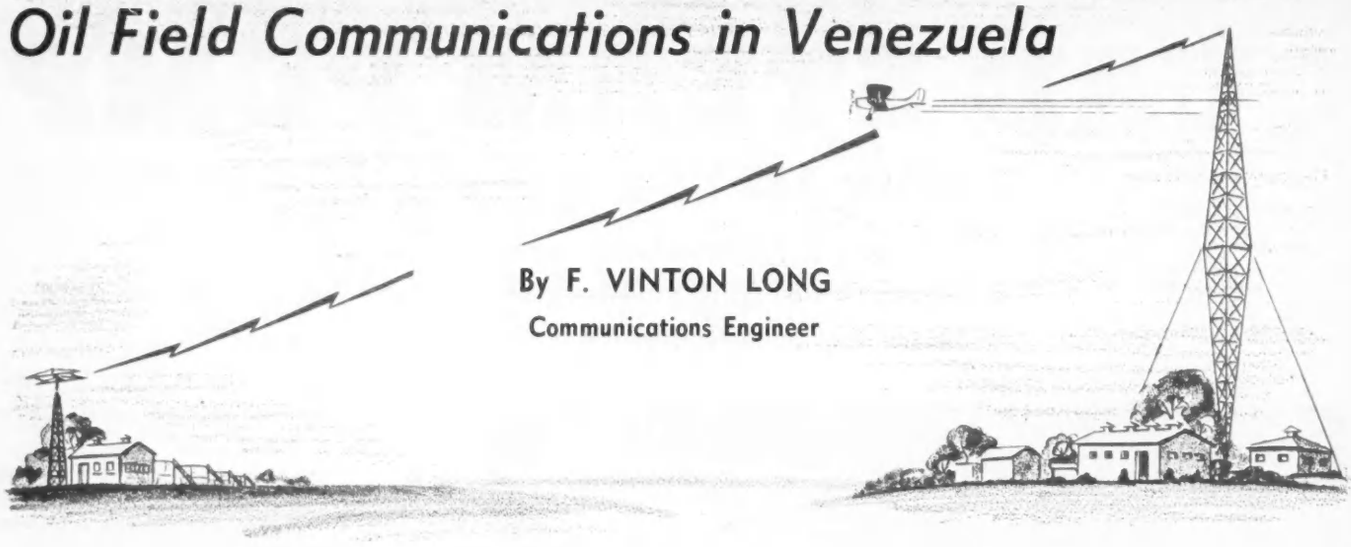
LUCEY

LUCEY EXPORT CORPORATION

233 BROADWAY . . . NEW YORK 7, N. Y.

Broad Street House, London, E. C. 2, England • Sterling Building, Houston, Texas • Calle Defensa 320, Buenos Aires, Argentina • San Fernando, Trinidad, B. W. I. • Calgary and Edmonton, Alberta, Canada

Oil Field Communications in Venezuela



By F. VINTON LONG
Communications Engineer

IN VENEZUELA, a company-owned radio is used or there is no communication. There are few countries with so great a need for communications and so little available. There are few landline telephone circuits as we know them in the U. S. and the only facility available is a government-owned radio system which provides radio-telephone connections of dubious quality between major cities. There are no teletype connections and telegrams are dispatched throughout the country through a single wire loop with ground return telegraph system.

Oil companies quickly found that if communications were to exist they would have to provide their own facilities—and they did. Radio seemed to offer most promise, and Shell Oil Company installed a long-wave radio station at Maracaibo in 1925 so it would be possible to talk to their fields near the lake. Except for summer static this system worked quite well. Next, Standard Oil Company (N. J.) (now Creole Petroleum Corporation) made the first oil field installation of high frequency radio in Venezuela, with stations at Caripito, Pedernales and Guiria.

Gulf Oil Corporation (Mene Grande Oil Company) was next, installing stations at Oficina del Tigre, Ciudad Bolivar, La Pena and Santa Ana in 1937. First use of the higher frequencies was made by Mene Grande and the forerunner of present microwave radio links were installed the same year for a circuit operating on 67 megacycles, across the Orinoco River. Following this The Texas Company, Venezuelan Atlantic Refining Company, Sinclair and Richmond Petroleum Company installed their own radio communications nets.

In 1941, Mene Grande instigated a move to standardize on 5692.5 kilocycles for all petroleum industry aircraft so that advantage could be taken of plane communication with any part of the country that contained company-owned radio stations. Full automatic dial telephone systems replaced the radio stations in certain areas; Mene Grande and Creole installed a jointly owned net connecting San Tome, San Joaquin, Puerto La Cruz, Caripito and other Eastern Venezuela points. However, high-frequency radio still provides the bulk of communications facilities.

Mobile radio units in vehicles have not been used to full advantage in Venezuela. This may be due to the annual tax placed on each radio transmitter by the Venezuelan government, but it is believed that in time all vehicles operating in the field will be so equipped.

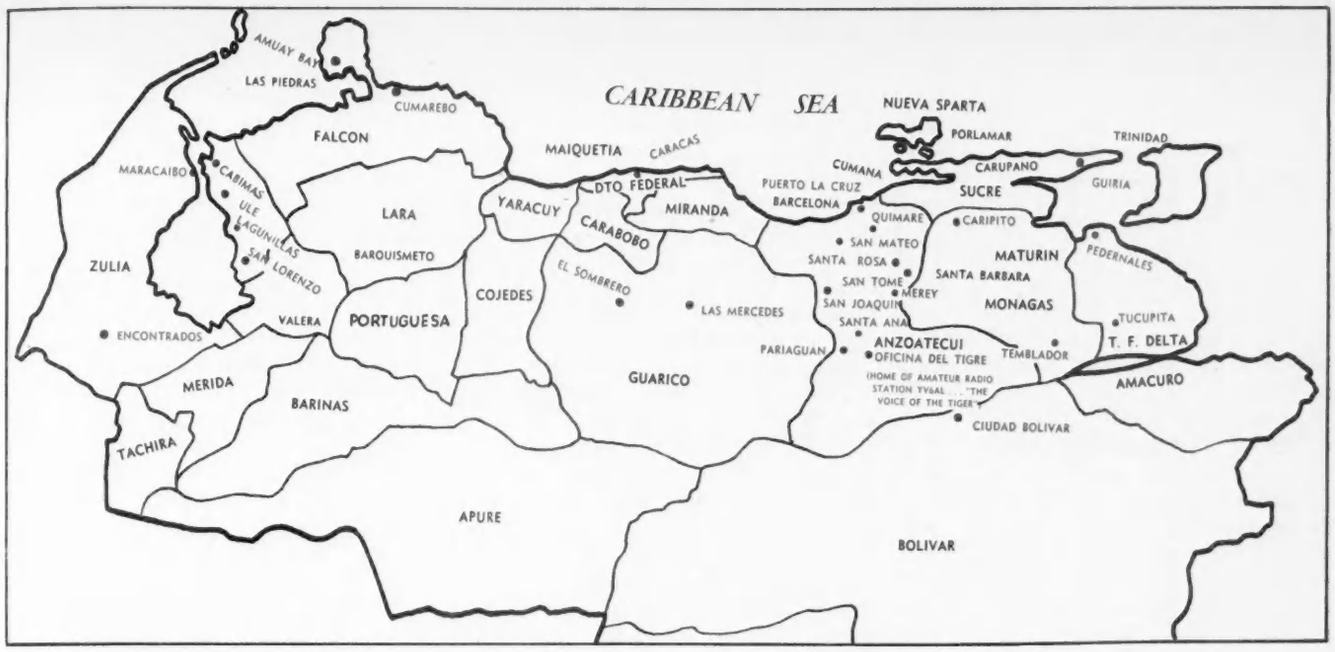
Creole has the first radio link installed purely for pipe line communication. The system extends from Ule, in the lake basin, to Creole's Amuay Bay terminal. This was installed in 1947, together with a backup, high-frequency link, airplane homing facilities for maintenance planes, and ground-to-air circuits.

COMMUNICATIONS in Venezuela are relatively primitive at best and the oil companies found that to maintain vital contact between headquarters and operations it was necessary to install their own facilities. Elementary radio installations were first installed, but these antiquated systems are presently being replaced by modern micro-wave circuits.

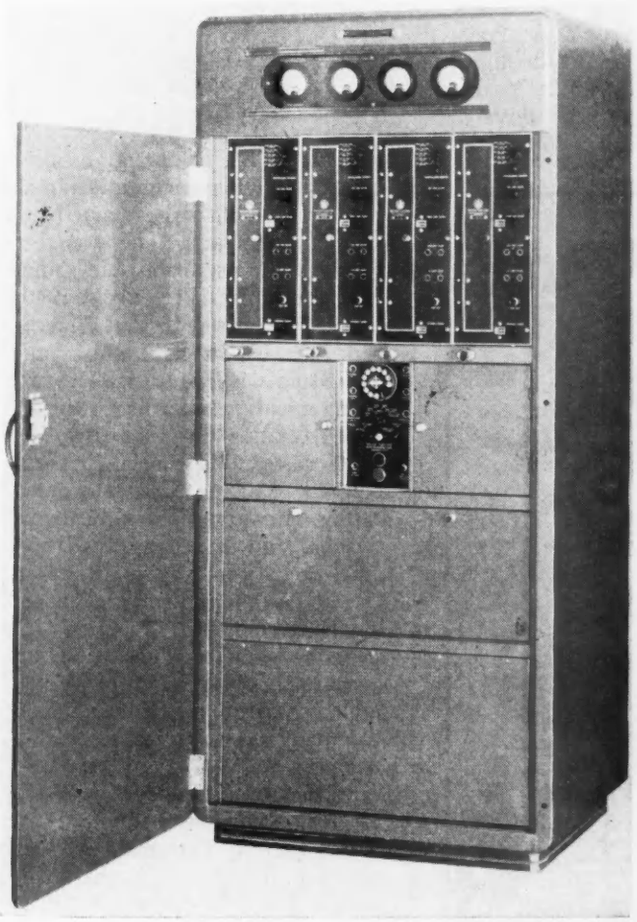
Radio has been used many times to rescue the sick and injured from isolated drilling camps. With hospitals few and far between, company aircraft sumoned by radio saved many lives. There was the humorous side, too, for all the housewives of the area kept their short-wave broadcast receivers tuned to company radio channels during the day. Some of the conversations were quite interesting, although inclined to be rather pungent despite company rules against profanity.

This monitoring by housewives had its good points. For instance, when they heard a distant station calling a station located in their camp, they often notified the local radio operator that they were being called so they could tune in their receivers. At least one life was saved in this way when a man was seriously ill in a Mene Grande oil camp in 1937. It was necessary to bring him out to a hospital by one of Creole's planes located at Caripito. As little communication was available then an urgent broadcast was put out by several Mene Grande stations in English and Spanish for anyone hearing it to notify the Caripito office of the emergency. The "grapevine circuit" came through, the broadcast was picked up by a housewife in Caripito; she notified Creole, and the patient was hospitalized the same day.

Venezuelan law prohibits amateur radio stations being operated except by duly licensed Venezuelan citizens. However, much of the oil field radio

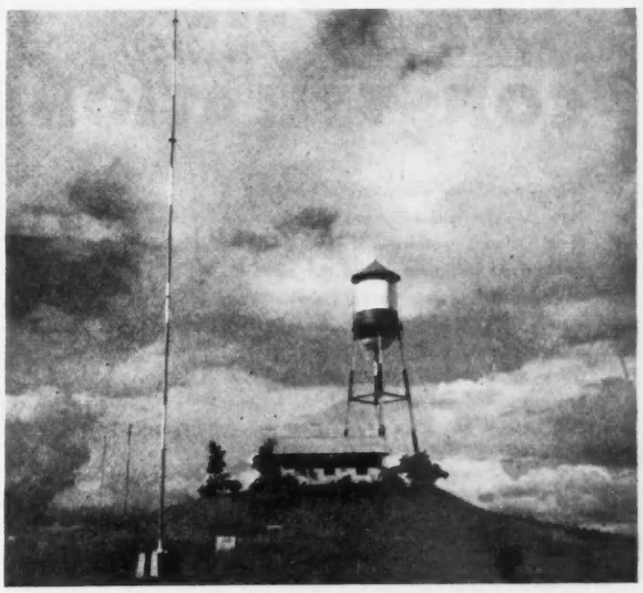


Oldtimer's radio map of Venezuelan oil fields.



ABOVE: Typical radio transmitter as used in the Venezuelan oil field camps.

Venezuelan nationals operating the station at San Tome. The station connects with Caracas and company airplanes.



RIGHT: Mene Grande's radio station at San Tome camp.

equipment was ideal for this use and could be thrown on the amateur radio frequency bands by merely changing the frequency. Occasionally, the temptation was too much to resist and arrangements were made with oil company radio operators, who were Venezuelan citizens, to obtain amateur station licenses in their name, with the provision that North American citizens with the yen for "ham radio" would provide the equipment and talk on the amateur frequency bands to their friends and relatives back home.

An amateur station, YV6AL, installed at Oficina camp and operating on the ten-meter amateur band, became well known in amateur long distance communications circles and was eagerly sought out by U. S. enthusiasts as a Venezuelan contact. Besides the legal operator of the station, the author did some hamming on this band and conversations were held with amateurs in other parts of the world.

The late Aubrey Schofield, then production superintendent with Mene Grande, was an ardent ham over this station and weekly schedules were held with an amateur station in Houston so Aubrey could talk with his wife. The phrase "Voice of the Tiger" was coined for station YV6AL because of its location at Oficina del Tigre and the station became well known to ten-meter hams throughout the world.

Finally, publicity in a radio magazine caused the Venezuelan government chief engineer and radio inspector to issue the following statement: "I know it is not possible that upstanding gentlemen would be bootlegging ham conversations over an oil company radio. I know, of course, that this rumor is not true—nevertheless, the practice must be stopped!"

Private radio stations are prevented by law from being installed in Caracas and the executive offices of the various oil companies there must rely on interconnection with the government stations to comunicate with the fields. At one time a move was made for the major companies to install a jointly owned station at Caracas, but local conditions among individuals and government officials made the project unsound and it was abandoned. The government feels that private stations could be easily seized by revolutionaries in the case of an emergency.

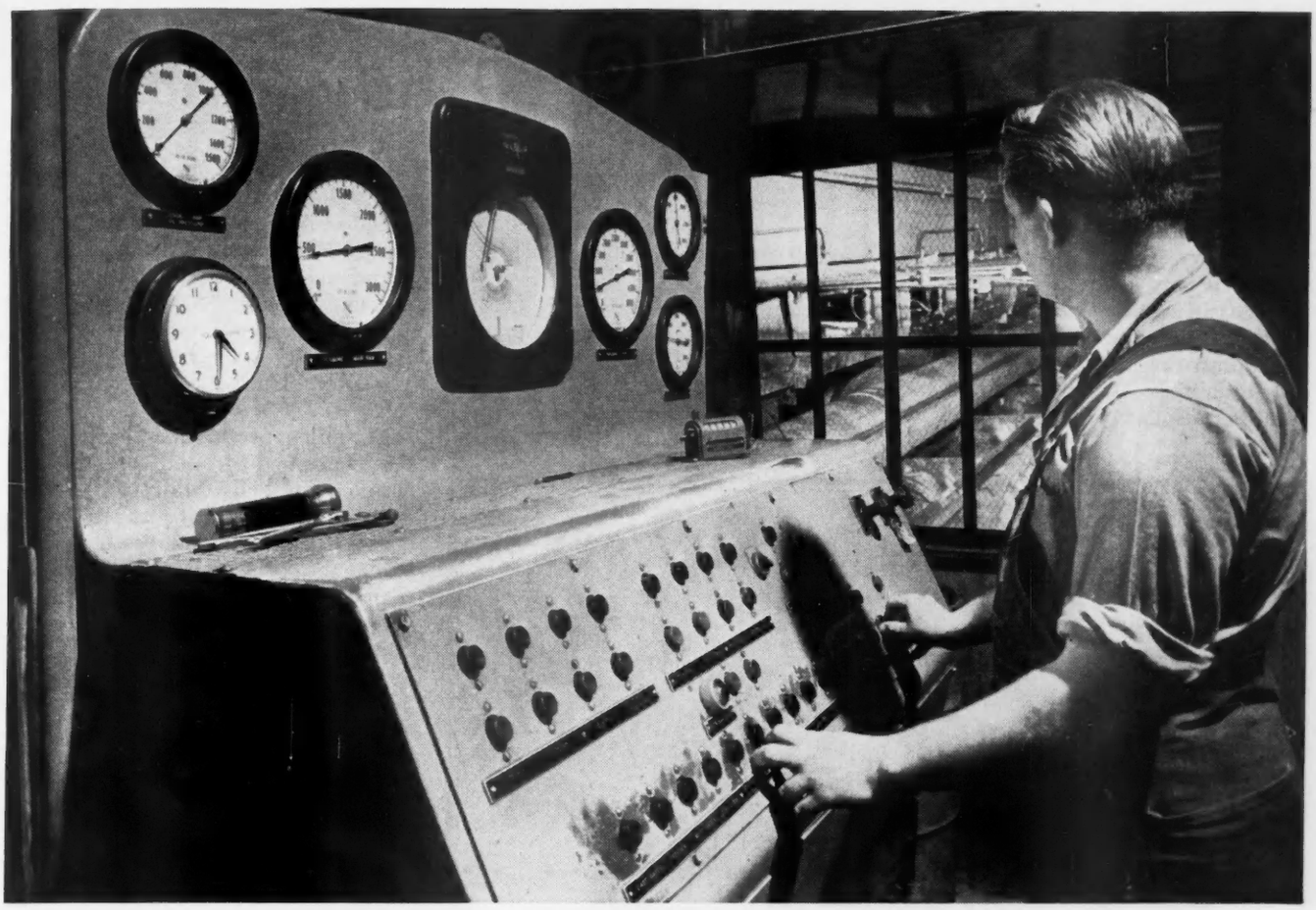
It is felt that Venezuela is a perfect setup for microwave radio links, either jointly owned by the petroleum companies or by the government. The government has contracted with a Swedish company to modernize the present communications system and install any needed new equipment, but several more years may lapse before the microwave system is used there. Telemetering and supervisory control of production and pipe line facilities over microwave links has only just begun and it is believed that the Venezuelan petroleum industry should study the advantages of jointly owned microwave systems. Through its use it is possible to make substantial reductions in personnel and obtain increased efficiency in communications at the same time.

The microwave era has arrived in the U. S.; it is just around the corner in Venezuela.

FASTEST SERVICE TO
VENEZUELA
C&S NEW luxury
CONSTELLATIONS
Flights each way every day aboard C & S New Luxury Constellations through the New Orleans gateway offer 300-m.p.h., pressurized cabin service to the oil fields of Venezuela. One carrier service from Houston, St. Louis, Chicago and Detroit, with connections at New Orleans to and from Dallas, Tulsa, Los Angeles and San Francisco. For reservations call the nearest C & S ticket office or your Travel Agent.
CHICAGO & SOUTHERN AIR LINES
GENERAL OFFICES • MEMPHIS 2, TENN.

About the Author

F. VINTON LONG has worked most of his life on foreign assignments involving communications. His interest in radio started at an early age; at 12, he was the youngest licensed amateur radio operator in the U. S. From 1930 to 1937 he was with Pan American Airways in Latin America, and from 1937 until 1943 was communication superintendent for Mene Grande Oil Company, C. A., in eastern Venezuela. He then entered the Army Air Force, Army Airways Communications System, and served as wing operations officer for the Eighth AACS Wing, which included 48 air fields in Latin America. In 1946 he went to Turkey on an airways survey mission for Westinghouse Electric International Company. As a free-lance sales engineer in 1947-48, Long concentrated on overseas projects. He is now a project engineer for Texas Eastern Transmission Corporation, Shreveport, in charge of design and construction of a 1400-mile microwave system extending from Shreveport to Linden, N. J. Long is a senior member of the Institute of Radio Engineers, and an associate member of the American Institute of Electrical Engineers.



He's doing 3 jobs for you

This man is operating equipment that does three important things to assure you of better Basalt-Kaiser line pipe:

It expands line pipe hydraulically within restraining dies to extremely accurate diameter, concentricity and straightness.

It strengthens line pipe through cold working—which means requirements of high yield strength specifications are met.

It tests line pipe with hydraulic pressure after the dies are opened. And while under pressure the pipe is struck blows of measured impact along the seam to further test the soundness of the weld.

Kaiser Steel pipe is being produced to conform to latest API specifications in diameters from ½ inch to 30 inches, and in lengths up to 55 feet. Shipping points are Fontana, and Napa, California.

It's good business to do business with

Kaiser Steel

KAISER STEEL PIPE SPECIFICATIONS • All pipe manufactured to latest A.S.T.M. and A.P.I. specifications

Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 20" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5⅝" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	22" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

Prompt, dependable delivery at competitive prices • KAISER STEEL CORPORATION Los Angeles, Oakland, Seattle, Portland, Houston, Tulsa, New York

Aramco Report Reveals Steady Progress

THE YEAR 1950 was significant for Arabian American Oil Company's extensive enterprise in Saudi Arabia. It was a year marked by an upsurge in crude production and allied field activities and by continued development of Aramco's influence on and guidance toward the physical and social betterment of its employes.

According to Aramco's annual report, its 1950 oil production of approximately 199,546,000 barrels was more than 25 million more than the 1949 output of 169,261,747 barrels. Peak production was reached in October, with an all-time high production of 643,147 barrels a day. During the year, 49,323,000 cubic feet of gas was sold. Twenty-one wells were completed in Abqaiq, Ain Dar, Qatif, and Haradh. Four wells were being drilled at the end of the year—2 at Ain Dar, 1 at Haradh and 1 at Dammam. Two rigs were being prepared for drilling at Ain Dar, and one was being prepared for offshore drilling at Safaniyah.

Matching production progress was the continued groundwork laid by Aramco and His Majesty's Government for a better understanding between the East and West. Emphasizing the progressively increasing realization that both the company and the government have a joint economic future, the supplemental agreement signed in Jeddah on December 30, 1950, resolved a number of long-standing problems and helped pave the way toward further progress in the company's development. The new arrangement increases the income of the government and will enable the economic development of Saudi Arabia to proceed even more rapidly.

This development was underscored by a stabilizing labor situation, further development of the company training program, establishment of a centralized health center, agricultural and water development, and large-scale company assistance in native industrial enterprises.

In the field, exploratory activities in geological, geophysical, and structure drill work continued at a high level. At the end of the year, Aramco had in operation 1 marine seismograph party, 1 land research party, 3 surface geological mapping parties, 2 joint triangulation and leveling parties, 2 gravity meter parties, and 2 structure drill parties.

A new asphalt manufacturing unit was completed in July, and went into production of finished asphalts in August. All production was used within Saudi Arabia. The Ras Tanura refinery manufactured 35,646,045 barrels of petroleum products during the year.

Another major achievement was the opening of Aramco's Tapline. It is the world's largest crude pipe line, and provides an outlet at the Mediterranean. The line stretches from the Persian Gulf to Sidon, Lebanon.

Aramco's employment picture was relatively stabilized in contrast to the previous five years, when a labor

SPACE NOW AVAILABLE

IN DOWNTOWN HOUSTON

Great Southern Building

Preston, Louisiana and Prairie Avenues

FOR LEASE

20,000 Sq. Ft. Ground Floor
20,000 Sq. Ft. Second Floor
20,000 Sq. Ft. Third Floor
} IMMEDIATE OCCUPANCY

60,000 Sq. Ft. of office space on 4th, 5th, 6th, and 7th floors, now being used by Great Southern Life Insurance Company. Will be available March 1st, 1953.

Passenger and Freight Elevator Service and Steam Heat
Hot and Cold and Ice Water Furnished

15c PER SQUARE FOOT PER MONTH

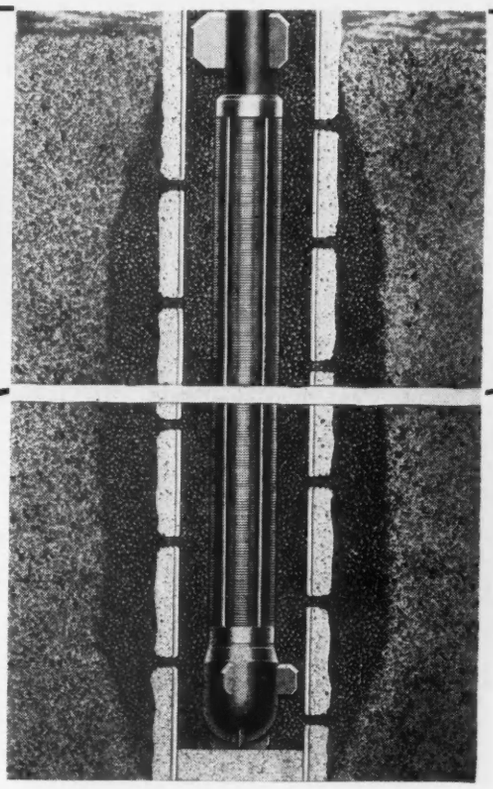
Will lease one or more floors to tenant but will not subdivide floors.
All improvements and alterations to be at tenant's expense.

WILL AIR CONDITION

VARNER COMPANY, *Owner*
PRestan 1242

HAROLD JOHNSON, *Agent*
Houston, Texas

THE LAYNE WAY



IS THE "Know How" Way

Something To Remember About GRAVEL PACKING

Business is rushing in **Gravel Packing.** Many old wells, long off of production because of sand troubles, are being reworked, Gravel Packed—and put back on production.

But remember—there is something more to Gravel Packing than just pumping gravel into a hole. To be successful, it must be done **right.**

Layne & Bowler are specialists in Gravel Packing—as many of the outstanding operators will testify. The "Layne Way" is the "KNOW HOW WAY."

Why not contact Layne & Bowler and get complete details—no obligation.

WRITE

THE LAYNE AND BOWLER COMPANY

General Office & Factory

8000 MARKET STREET HOUSTON, TEXAS

force far in excess of requirements for normal operating procedure was employed in the construction program. Recruitment of Palestinian Arabs was an important factor in the 1950 labor program, even though emphasis was placed, as usual, on employing Saudi Arabs, who comprise 62.1 percent of the labor force.

In connection with the company's continued development of a program to benefit its employes, 1950 marked the first full year of operation of the company's five-year training program, started in 1949. At the close of that year 2496 Saudi Arabs, or 24 percent of Saudi Arabs employed, were enrolled; at the end of 1950 the enrollment had jumped to 4598, or 42 percent.

Another segment of Aramco's program to help employes help themselves is the vestibule training, inaugurated at Dhahran in December 1950. This training is designed to introduce new employes into the company, and it includes a maximum period of 90 days for screening of prospective employes, appraisal by a series of intelligence tests, trial jobs, and subsequent assignment to regular production jobs.

During the year, further steps were taken toward establishing a complete health center in Dhahran to serve all company areas. The dental laboratory was moved from Ras Tanura to Dhahran, completing the centralization of all laboratory facilities. Abqaiq hospital was closed early in the year, and bed patients now are taken to Dhahran, where they can obtain complete medical service. Emergency facilities are still in operation at Abqaiq.

Out-patient treatments numbered 310,197 during the year, while 6821 persons were hospitalized. Disorders encountered with frequency were smallpox, typhoid fever, pneumonia, and schistosomiasis, as usual.

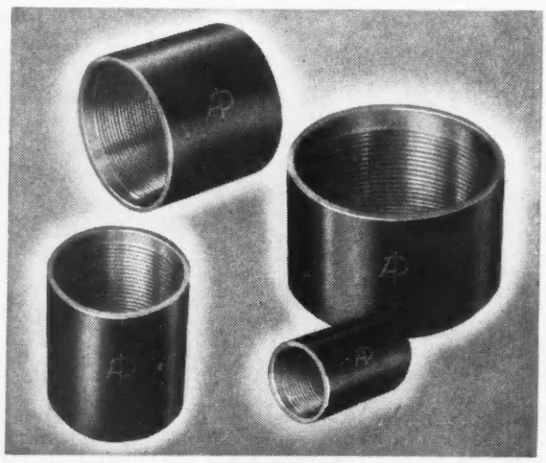
In addition to carrying out the annual DDT spraying program in company areas, Aramco also treated two towns in the Qatif oasis with DDT on an experimental basis during the year. Both towns, Safwah and Al Ajam, showed declining malaria rates.

Other company efforts directed toward improving the lot of the Saudi Arabs included the construction of a police station at Dhahran, continued operation of the Al Kharj farms as a commercial project for the benefit of His Majesty's Government, a further study of the Riyadh area hydrology, erection of 86 permanent dormitories providing permanent housing space for 2002 additional Arab employes, and 28 prefabricated demountable buildings providing space for 168 Italian employes.

And so, the Aramco venture, now 17 years old, has become a thriving international enterprise. The union of American capital and development skills with the crude resources of Saudi Arabia is bringing profits to the government and to the company, and makes possible the building of a better life for the people of Saudi Arabia.

When You Buy Couplings
Buy HARRISBURG

carefully controlled inspection FOR QUALITY
bored and threaded on special machines FOR ACCURACY
a complete range of sizes and types FOR ADAPTABILITY



HARRISBURG Seamless Steel Pipe Couplings . . . made to A.P.I. and A.I.S.I. specifications . . . are bored and threaded on special machines for accuracy of form, height, angle, and lead.

SEE OUR CATALOG IN THE COMPOSITE CATALOG

CONTACT THESE DISTRIBUTORS—OR WRITE HARRISBURG

HOUSTON 1 • Henry H. Paris, Distributor, Inc.
LOS ANGELES 54 • Republic Supply Company of California
LOS ANGELES 58 • Howard Supply Company
TULSA 1 • W. C. Norris, Manufacturer, Inc.

HARRISBURG STEEL CORPORATION
Harrisburg 8, Pennsylvania

Custom-Built Quality Products in Quantity
98 YEARS IN PENNSYLVANIA'S CAPITAL

Shell to Build Australia's Largest Distillation Plant

Australia's largest crude distillation plant will be built at Geelong, Victoria, by Shell Company of Australia, Ltd. Scheduled for completion by the end of 1953, the 250-acre plant will have an eventual output of 7,103,000 barrels annually.

Designed primaritly to reduce Australia's dollar shortage, the plant's feed stock will be obtained from British Borneo, a nearly 100 percent sterling source.

Plant output will include the full range of petroleum products. Annual volume initially will be approximately 5,327,000 barrels.

Men interested in

OIL AND GAS LOANS

will find that the Oil and Gas Division of The Second National Bank of Houston offers these advantages: (1) cooperative service by specialists of long experience in oil and gas operations; (2) a policy of prompt consideration and decisions; (3) a definitely affirmative attitude towards constructive oil and gas projects; (4) adequate loaning capacity to meet any needs.

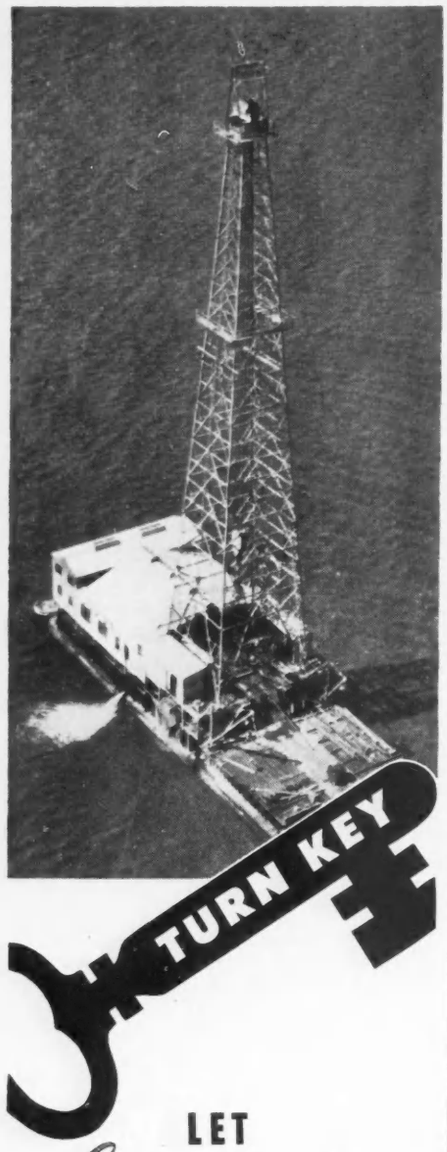
We will welcome the opportunity of discussing your plans and programs. Please contact the Oil and Gas Division.

44 Years of Service to the Southwest

The **SECOND NATIONAL BANK OF HOUSTON**

MAIN AT RUSK

CAPITAL AND SURPLUS TEN MILLION DOLLARS . . . MEMBER F.D.I.C.



LET
Levingston
DO THE COMPLETE JOB
with the
machinery
of your choice

From crown block to barge bottom, Levingston is prepared to accept the entire responsibility of constructing and rigging-up your submersible drill barges on a turn-key basis. You select the tools or equipment, and Levingston's experienced organization will install them for safe and efficient operation on marine locations.

Levingston
SHIPBUILDING CO.
Orange, Texas

New Oil Regulations for Saskatchewan Adopted

New oil regulations governing the search, development and production of oil in Saskatchewan Province have been announced.

Major changes involve the time limit for exploration permits, permit rental, Crown reserves and provision of detailed exploration work requirments. There are a number of minor changes in other phases of the oil regulations. The only change in the royalty scale is provision of a minimum royalty of ½ cent per 1000 cubic feet of natural gas.

One significant addition to the regulations is the definition of petroleum as "any naturally occurring fluid of hydrocarbon and includes natural gas." Petroleum was not defined in the old regulations.

The first major change in the permit system is the consolidation of three types of permits, including subsurface and geophysical, into one. In the future only one type of exploration permit carrying a three-year term will be issued. Previously, subsurface permits were for a maximum period of 15 months, and geophysical for 21 months.

J. H. Brockelbank, Minister of Natural Resources, said the period of time for exploration permits has been extended since experience had shown that 15 or 21 months was not sufficient time for a company to complete an intensive exploration program.

However, this advantage for the oil companies is balanced by provision for rentals during the permit period. The rental scale is 2 cents an acre for the first year, 5 cents an acre the second year, and 10 cents the third year. Under the old regulations, no rental was paid during the permit period.

The new regulations allow the operator to lease a maximum area 3½ miles square compared to a maximum of three miles square in Alberta. If no side of the lease area is more than two miles long, the operator may lease up to 60 percent of the petroleum rights owned by the Crown in that township. Where two sides of the area are more than two but less than three miles long, the operator may lease up to 50 percent; and where the sides are more than three miles long but less than 3½, the operator may lease up to 40 percent. All leases, as under the old regulations, will be for a 21-year term, renewable for 21 years, with a $1 per acre per year rental.

The scale of royalties on oil production remains the same, with a 5 percent royalty on a well producing 900 barrels or less a month ranging up to a 15 percent royalty on wells producing more than 6000 barrels a month. The only change in this respect is that now the royalty may be based on monthly instead of daily production.

Drilling and Production Stepped Up in Canada

Canada's oil activity for the first two months of 1951 reflected a sharp improvement over the same period in the preceding year. In January of this year, crude production reached 2,810,415 barrels, in February 2,605,078 barrels, with a two-month cumulative output of 5,415,493 barrels. This is a marked increase over the production in January 1950 of 1,800,696 barrels, in February of 1,816,854, with a two-month cumulative total of 3,617,550—1,797,943 barrels less than the current year.

Well completions also showed a gain over the rate which enabled Canada to complete 337 wells in 1950. During the first two months of 1951, 103 wells were completed.

Alberta Supplying Nearly Half of Canada's Needs

Alberta oil fields have raised Canada's annual crude production to nearly one-half its requirements.

This disclosure was made by Dr. Oliver B. Hopkins, vice president of Imperial Oil, Ltd., of Canada at the semi-annual meeting of the American Society of Mechanical Engineers in Toronto in the middle of June.

Assuming Canada's oil consumption continues to increase as it has in the past several years and that no large new discoveries are developed in the meantime, Dr. Hopkins estimated "conservatively" that the country would be 40 percent self-sufficient in crude production in 1953.

He said the combined market for oil produced in the Alberta province during 1951 will be about 115,000 to 120,000 barrels daily, or about a third of Canada's current daily consumption of 350,000 barrels.

German Plant Adds Units

A refinery on the Essen Canal Harbor, erected by Kleinholz and Company of Essen and Kraftstoff-Handelsgesellschaft mbH of Berlin, will be completed during 1951 by the addition of a thermal cracking unit and a tank farm.

Now—Free TRUCK SAVER *Inspection*

First step of a complete TRUCK SAVER *plan*

- **Available to all International Truck owners**
- **No cost, no obligation for a 99-point checkup**
- **For a limited 3-month period ending September 30**

How easily you can keep your Internationals operating at peak efficiency in an uncertain future may depend on what you do within the next 90 days.

If you take advantage of our Truck Saver Inspection, you'll be taking the first step toward putting your Internationals in shape for the "come what may" days ahead.

Since this inspection doesn't cost you a penny, you have everything to gain—nothing to lose. You can save dollars now and perhaps many more before the end of 1951.

So get ready now to keep your trucks on the job despite shortages. The sooner you get your free Truck Saver Inspection, the sooner you see practical reasons why you should take advantage of our complete International Truck Saver Plan.

Look what the complete International Truck Saver Plan offers

The complete International Truck Saver Plan has been developed by experts, after a thorough study of today's truck operating problems. It offers these benefits to International Truck operators:

1. Better performance over a longer truck life: trucks are kept in shape to do the most efficient job possible until they can be replaced by new units.

2. Delays minimized in getting new parts: by anticipating future requirements, the demand for needed parts can be accurately estimated.

3. Maintenance costs cut, down time reduced: by preventing major breakdowns, a big saving is effected in both time and money.

4. Truck value maintained: trucks kept in the best possible condition are worth more when it's time for replacement.

Take advantage of the International Truck Saver Plan now

If you want to save yourself trouble and money in the months ahead, you belong in the International Truck Saver Plan.

Get your free Truck Saver Inspection—find out from your International Truck Dealer or Branch how the plan can help *you* keep your Internationals going at peak efficiency.

International Harvester Builds
McCormick Farm Equipment and Farmall Tractors . . . Motor Trucks
Industrial Power . . . Refrigerators and Freezers

International Harvester Company • Chicago

INTERNATIONAL TRUCKS

Heavy-duty engineered for the long haul

SECONDARY MODERN RECOVERY
TECHNICAL CONSULTING PRODUCTION ENGINEERING SERVICE, INCLUDING CORE ANALYSIS
PRESSURE MAINTENANCE WITH GAS OR WATER
REPRESSURING WITH GAS OR WATER
Summary Sheet of Recoverable Oil & Reservoir Data

from our Core Analysis Laboratory
NEW PHONE NO.
3-2167
Replacing 8466 and LD 66
SURVEYS
ESTIMATES
DESIGN
INSTALLATION
SUPERVISION
PETROLEUM ENGINEERS
CABLE & STINE
WICHITA FALLS, TEXAS

IPAA Committee to Study Hemisphere Oil Supply

J. Ed Warren of Midland, Texas, president of the Independent Petroleum Association of America, has appointed a committee to study the supply and availability of oil in the Western Hemisphere. IPAA directors authorized the appointment of the committee at a recent meeting in Denver.

The study will include availability of oil in the Western Hemisphere; sources of supply, including means of making them available for future use; means of building excess productive availability for future industry exploration for emergency defense requirements; and recommendations of legal methods of correlating sources of supply to encourage progressive growth without injuring individual areas.

"The study of other Western Hemisphere sources of supply, their extent and their availability is at the time important to our national security," said Warren.

Charlton Lyons, Shreveport independent operator, was named chairman of the committee and L. Dan Jones of the Washington IPAA, was chosen secretary.

American Independent Drills New Tabasco Discovery Well

Indications are that a discovery well in Mexico's Tehuantepec Isthmus area, the announcement of which was made about the middle of June, will flow at a rate of 200 to 250 barrels daily of 32.5-gravity oil. The well, known as Rabon Grande 1, is in the state of Tabasco.

Ralph K. Davies, president of American Independent Oil Company, the firm which drilled the exploration, said production tests were being continued and that additional drilling would be required before the significance of the strike can be fully appraised. However, Davies described the new oil field as apparently a "distinctly important discovery." A second well was scheduled to be spudded in immediately.

Pogue Warns of Increasing Socialism in Oil Countries

Socialistic tendencies in numerous oil-producing countries are retarding development of the world's petroleum resources, Dr. Joseph E. Pogue, a Gulf Oil Corporation director and oil industry consultant to the Chase National Bank, New York, said in his opening address at Gulf's Production Engineering Conference held in Pittsburgh in June.

Authority and writer on oil economics, Dr. Pogue said governmental operation of oil industries, or hampering control of the industry, is producing only a fraction of the possible yield in many oil-rich areas abroad.

Should socialistic tendencies prevail on a global scale, one factor of the resulting decline would be failure of oil production to keep pace with consumption needs, he predicted. This would happen because oil exploitation has succeeded to an important extent only under competitive, free enterprise conditions.

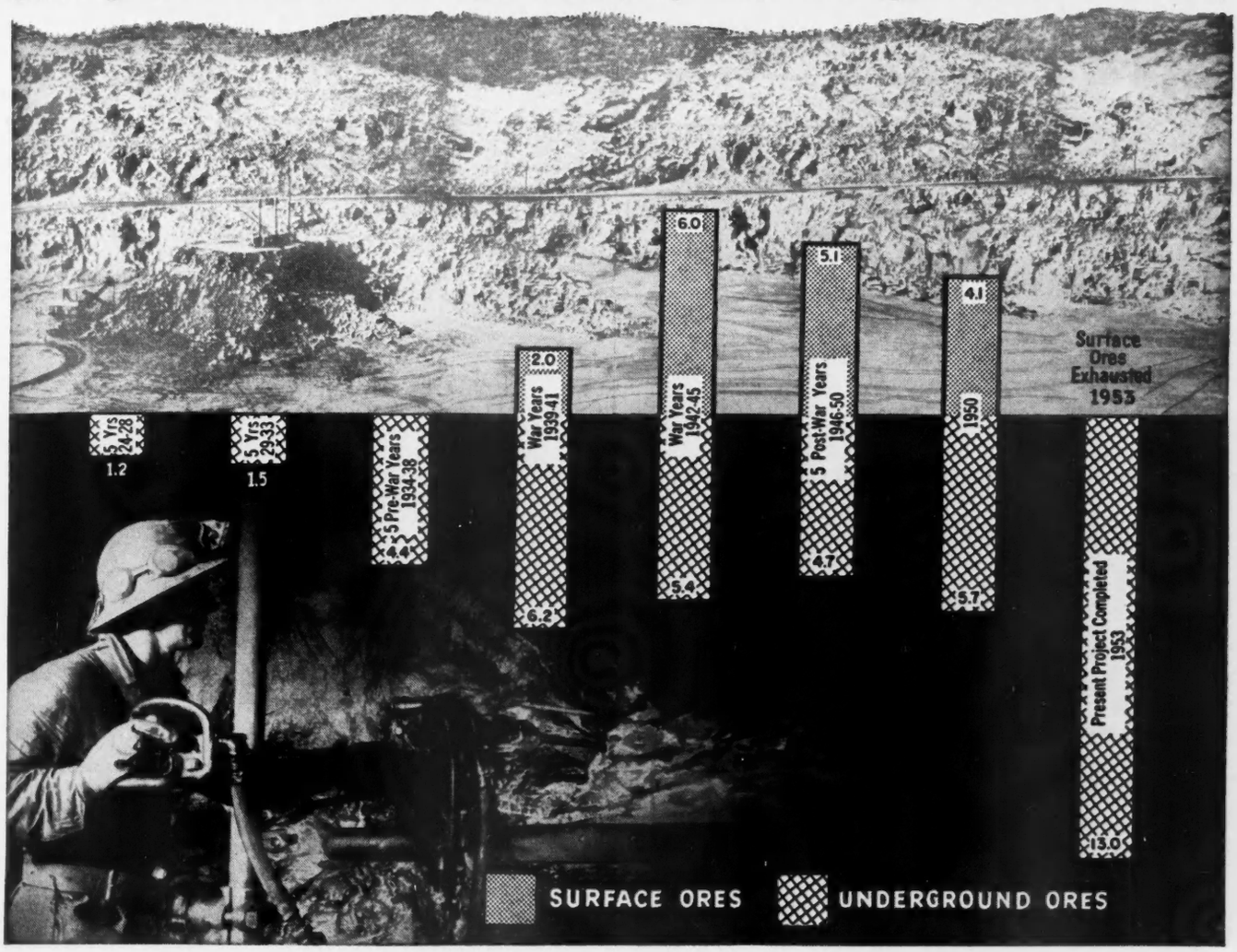
Prejudices against foreign capital and development has been a prime factor in barring free enterprise from effectively operating in many largely undeveloped oil regions, he said, and such prejudice must be overcome if these needed resources are to be utilized.

Pointing out that oil reserves in the ground are in no sense a reality where the technology to get them out is lacking, Dr. Pogue said petroleum science, which free enterprise alone has brought to its present efficiency, can produce no oil where political factors shut out its use.

CONTACT YOUR FAVORITE SUPPLY HOUSE
PARKERSBURG MACHINE CO. PARMACO PARKERSBURG, W. VA. U.S.A.
The House of Courteous Service
50 YEARS OF SERVICE
And on our 50th Anniversary we again invite you to Standardize on
PARMACO PRODUCTS
PARKERSBURG MACHINE COMPANY
PARKERSBURG, W. VA.

PARELEX
Electric Heaters for Oil Wells
Bottom Hole Tubing and Flowline Heaters for Paraffin and Heavy Crude
Model BH3
Write for Details
PARELEX CORPORATION
P. O. Box 552
HOUSTON 1, TEXAS

Underground and surface ORE MINED (yearly average—millions of tons)



Underground for Defense

...started more than 10 years ago

STRENGTH...military and economic ...depends on productivity. And productivity depends on men who have devoted long years to their specialized chosen field of endeavour.

Such men with "know-how" mine nickel from the rocky rim of Ontario's Sudbury Basin ...

By increasing output with maximum speed and drawing on reserve stocks of nickel previously accumulated, they helped raise deliveries of nickel in all forms during 1950 to 256,000,000 pounds ... a record for any peace-time year.

This record, 22% greater than the 209,292,257 pounds delivered in 1949, was no accident ...

In 1937, INCO launched a vast long-range project which now makes it possible to meet the military requirements of the United States, Canada and the United Kingdom. In addition, nickel deliveries are being made to government stockpiles and the balance of the supply is being rationed among civilian consumers in all markets throughout the free world.

Since the inception of International Nickel, its fixed policy has always been to increase the supply of nickel. To meet today's needs, INCO went underground years ago.

Anticipating the eventual depletion of Frood-Stobie open pit surface ores, more than 10 years ago, INCO embarked on a program of replacing open pit with underground capacity. This required extensive enlargement of underground plants, development of new methods of mining not previously undertaken and the revamping of metallurgical processes to cope with difficulties in recovering nickel from the new types and lower grades of ores which have to be reached.

Major expansion in output of nickel from underground operations is being driven to conclusion with utmost speed. There is still much construction to be done and a number of mining and metallurgical problems remain to be solved and tested in actual operation. Barring unforeseen interruptions, full conversion to underground mining should be completed in 1953.

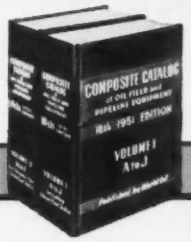
When the present undertaking is completed, INCO will be able to hoist 13,000,000 tons annually, and the size of its underground mining operation will surpass that of any other non-ferrous base metal mining operation in the world.

This underground expansion is being completed by INCO without interrupting current production of nickel, which is at maximum capacity.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

NEW AND IMPROVED EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG



Weld Inspection Process

This item supplements Magnaflux Corporation data on page 3119 of Composite Catalog, 18th Edition.

Equipment and services are now available for complete inspection of circumferential welds during pipe line construction. The Magnetic Particle Inspection method employs local magnetic leakage caused by detrimental defects to attract and hold finely divided Ferro-Magnetic particles in a pattern on the weld surface. The powder pattern builds up as the weld is locally magnetized with high amperage currents, to indicate the exact location, extent and type of defect. Detrimental internal defects such as lack of penetration, as well as surface cracks, are revealed. Since the attraction of the particles and the forming of a pattern is a visible phenomenon on the weld surface, visual inspection can be made simultaneously with Magnaflux inspection.

For additional information write Magnaflux Corporation, 5900 Northwest Highway, Chicago 31.

Swinging Final Drive

This item supplements Mid-Continent Supply Company data on pages 3337-3364 of Composite Catalog, 18th Edition.

Added to the swinging compounds in the Mid-Continent line is a new swinging final drive which eliminates the problem of aligning sprockets and connecting the chain between the compound and the input of the drawworks. With the swinging final drive and swinging compounds the only chain broken is the rotary chain.

Designed for use with the Mid-Continent multiple engine rig drive, the swinging final drive is enclosed in an oil-tight, dustproof case. By pivoting the final drive and the swinging compounds to a vertical, locked position, skid-mounted elements of the multiple engine rig drive can be separated and moved as units.

Lubrication is by spraying a stream of oil directly on the sprockets of the swinging final drive. Interior channel bracing along the sides of the case serves as an oil reservoir which allows an oil pressure spray to lubricate the chain. In operation, oil is pumped into the channel reservoir, sprayed on the sprockets, and drained by gravity to the lowest part of the case, where it is picked up by the pump again. A plexiglas inspection plate on each side of the drive case allows the operator to see the effectiveness of the spray lubrication.

Either sextuple or quadruple 1½-inch chain is used in the swinging final drive. A smaller, ⅝-inch pitch chain drives the oil pump from the lower shaft.

For additional information, write Mid-Continent Supply Company, P. O. Box 189, Fort Worth.

Rotary Hose

This item supplements New York Belting and Packing Company data on pages 3667-3673 of Composite Catalog, 18th Edition.

A new reinforced rubber and fabric rotary hose for high pressure oil well drilling operations consists of four plies of wire reinforcing, together with heavy duty rubber and fabric. The hose is flexible and kink-resistant.

The new hose, known as "Green Triangle" rotary hose, eliminates the need for transferring from rubber to steel hose in high pressure work, and will drill a well from top to bottom, regardless of pump pressure or gas pressure, according to the manufacturer.

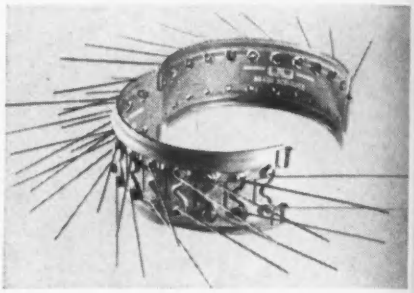
For additional information, write New York Belting and Packing Company, Passaic, N. J., or the distributor, Continental Supply Company, Continental Building, Dallas.

Save Time—Write Direct

As a service to readers, all items in WORLD OIL include the complete mail address of the manufacturer. This makes it possible for those desiring additional information to write any manufacturer without the delay occasioned by going through offices of WORLD OIL, and enables subscribers to request specific data in which they are particularly interested.

Scratcher

This item supplements B and W Incorporated data on pages 457-462 of Composite Catalog, 18th Edition.



Hinged construction has been provided in the B and W Nu-Coil Scratcher. A heavier base and window type hinge are combined with a high tensile spring curved pin. The scratcher is of the latch-on type and is adapted to installation on external upset casing or on casing joints on which the welded scratcher stop lugs are placed in the casing storage yard or on the dock before moving to a marine location.

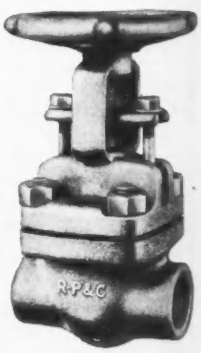
The scratcher may also be used on small drill pipe "stingers" for cement plug placement on open hole. These assemblies may be dressed at the rig location, without welding service.

For additional information, write B and W Incorporated, P. O. Box 5266, Houston 12; or 3545 Cedar Avenue, Long Beach 7, Calif.

Gate Valves

This item supplements American Chain & Cable Company, Inc., data on pages 212-213 of Composite Catalog, 18th Edition.

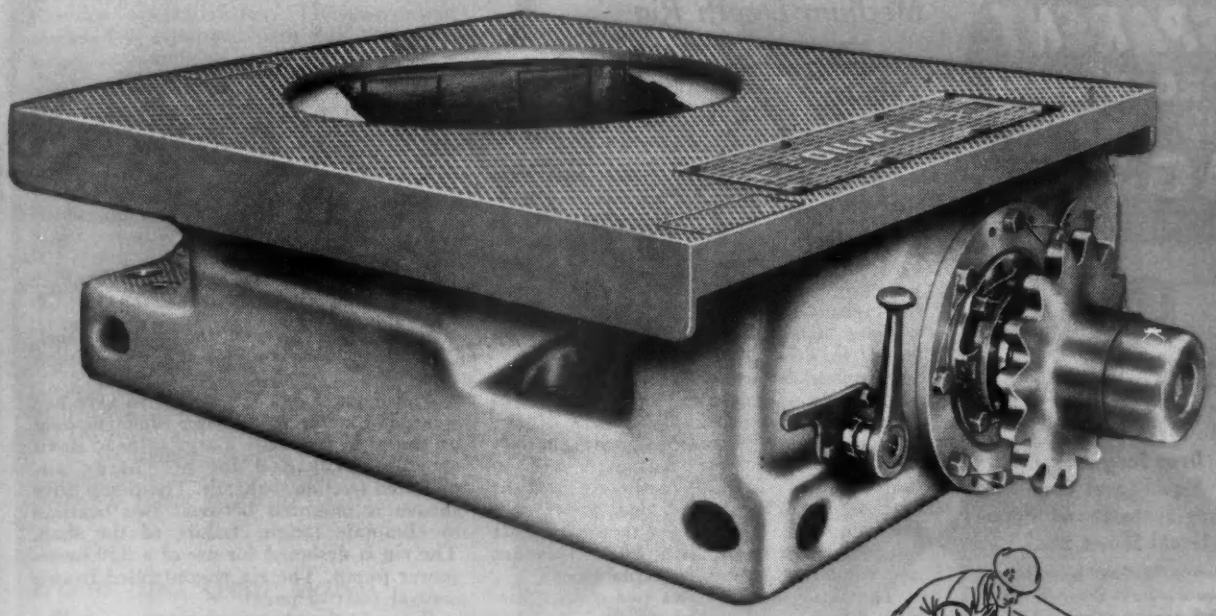
The R-P&C forged steel gate valve is designed especially for high-pressure applications. The valve has a bolted steel bonnet. Tongue and groove joint has soft iron gasket for tightness under varying service conditions. The extremely hard wedge facing minimizes seizing, galling and abrasive wear. Stainless steel gland bolts and nuts prevent freezing or corrosion while the two-piece gland and follower apply uniform pressure on packing.

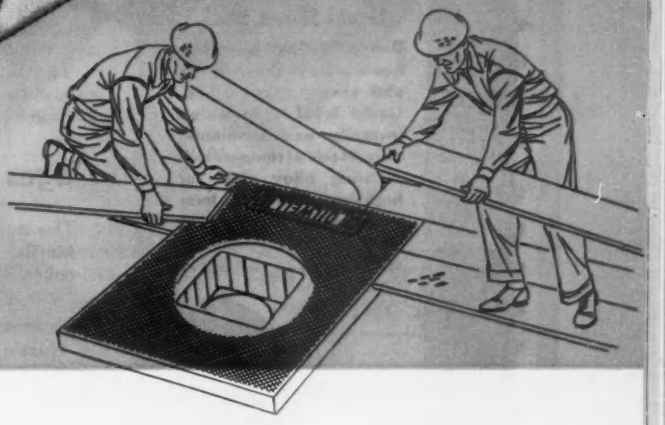


Valves are available in ¼- to 2-inch sizes.

For additional information write R-P&C Valve Division, American Chain & Cable Company, Inc., Reading, Penn.

RECTANGULAR Guards...now available for "Oilwell" Rotaries





You don't need to waste time making round openings to install "Oilwell" Rotaries with rectangular guards. All models are now available with these easy-to-fit guards—or, if you prefer, you can still get the round type.

Choose the size to fit your needs

"OILWELL" 26-HD OILBATH ROTARY . . . conservatively rated for drilling depths to 17,000 feet and drilling speeds to 500 rpm. Full 26-inch cylindrical table opening permits the use of large casing.

"OILWELL" 21-A SUPER-SPEED ROTARY . . . balanced to operate smoothly at speeds up to 1000 rpm. Conservatively rated for depths up to 17,000 feet. Cylindrical table opening is a full 21 inches.

"OILWELL" 20½-INCH OILBATH ROTARY . . . designed for drilling depths to 13,000 feet and speeds up to 500 rpm. Cylindrical table opening is a full 20½ inches.

"OILWELL" 17½-C AND 17½-D OILBATH ROTARIES . . . designed for drilling depths of 9,000 feet and speeds up to 500 rpm. Both have a full cylindrical table opening of 17½ inches. They differ only in the length of their pinion shaft assemblies . . . the 17½-C measures 44 inches and the 17½-D measures 53¼ inches from center of table to center of drive sprocket.

SERVICE RATINGS

"OILWELL" ROTARIES	17½-C	17½-D	20½"	21-A	26-HD
Rated Supportable Dead-Load Capacity.....tons	200	200	250	300	350
Maximum Recommended Drilling Depth.....feet	9,000	9,000	13,000	17,000	17,000
Maximum Recommended Table Speed.....rpm	500	500	500	1,000	500
Gear Ratio.....	3.28:1	3.28:1	3.82:1	2.61:1	3.84:1

Try "Oilwell" first for rotaries . . . they have been first choice with drillers for years, because of their smooth, quiet operation and trouble-free performance. Ask for your copy of Booklet No. 5-51.

OIL WELL SUPPLY COMPANY

Branches Serving All Oil Fields

Executive Office—DALLAS, TEXAS
Export Division Office—
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.

Division Offices—CASPER, WYOMING
COLUMBUS, OHIO . . . DALLAS, TEXAS
HOUSTON, TEXAS...TULSA, OKLAHOMA
LOS ANGELES, CALIFORNIA

USS TRADE MARK

"OILWELL"

TRADE MARK

UNITED STATES STEEL

PENBERTHY
REFLEX and TRANSPARENT
DROP FORGED STEEL LIQUID LEVEL GAGES

PENBERTHY
REFLEX
Drop Forged Steel
Liquid Level Gage
Empty Space Shows White
Liquid Shows Black

Due to "Reflex" principle, liquid always shows black and empty space white. Liquid level is indicated instantly and unmistakably. Made of temperature resisting alloy steel for high pressure and temperature service. Conforms with API and ASME requirements.

PENBERTHY
TRANSPARENT
Drop Forged Steel
Liquid Level
GAGES

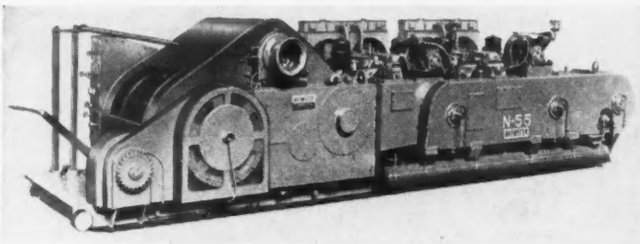
Glass front and rear permits observation of color and density of liquids under high pressures and/or temperatures. Highest quality—made of temperature resisting alloy steel. Conforms with API and ASME requirements.

3277-C

PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant—Windsor, Ontario

Medium Depth Rig

This item supplements The Brewster Company data on pages 841-876 of Composite Catalog, 18th Edition.



Designed for 6500-foot drilling, Brewster's N-55 rig is equipped for 400 horsepower input and has eight drum speeds forward with four reverse and four rotary speeds forward with two reverse.

The brakes are cooled by circulating water. Compounds are available for two or three engine hookups. Design of the transmission makes possible rapid changes of speed even while the parts are in motion. Over-all width of the rig is eight feet. High and low speed air-type crutches are mounted on the ends of the drum shaft outside the drum housing where they are accessible for service and replacement.

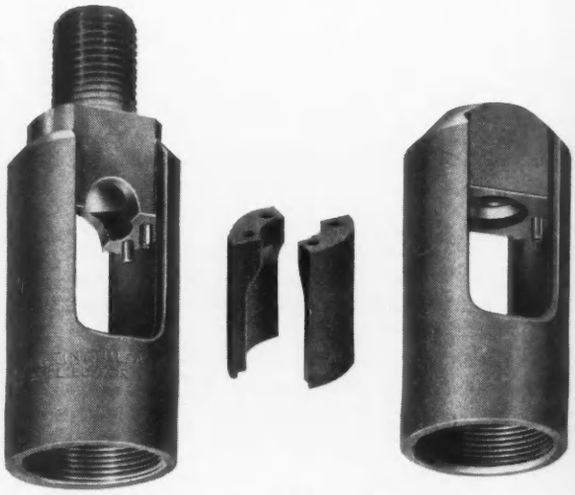
The input shaft carries two master friction clutches for forward speeds and planetary gear friction reverse, all controlled by one four-way valve on the control panel. This valve also controls the transmission brake.

The drum has a large core to save line wear and a large diameter shaft to hold up under heavy loads. Large cathead shafts are also provided for mounting air-operated friction catheads. The pump drive sheave is mounted between two bearings to eliminate fatigue failure of the shaft. The rig is designed for use of a 350 horsepower pump. The rig is controlled from a central control panel.

For additional information, write The Brewster Company, Shreveport.

Cages

This item supplements John M. Martin, Manufacturer, data on pages 3189-3191 of Composite Catalog, 18th Edition.

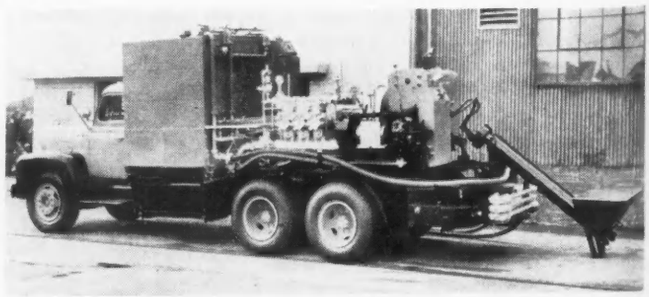


Martin cages are equipped with synthetic rubber ball guides (perforated to prevent blisters), which are held in place by both mechanical means and oil proof cement. The well-known properties of rubber, such as resilience (against beating of the ball), resistance to sand abrasion, non-magnetic character, and electrical resistance, are thus employed to combat problems frequently encountered in the use of cages. The life of the cage, as well as balls and seats, is consequently extended, the manufacturer claims.

For further information write John M. Martin, Manufacturer, P. O. Box 1446, Tulsa.

Cementing Unit

This item supplements International Cementers, Inc., data on pages 2494-2496 of Composite Catalog, 18th Edition.



Maximum pressure with good volumetric capacity are provided in a new ICI cementing unit, 108-T. The unit uses an Oilwell 48P Special, triplex plunger pump with 4½ x 8-inch hardened and ground steel plungers. Maximum pressure developed is 7500 pounds per square inch, and volumetric capacity is 260 gallons per minute, figured at 90 percent efficiency.

Truck engine power is transmitted to the pump through the main five-speed

transmission, the Fuller Power Take-Off, two counter shafts and chain reduction. A Chrysler six-cylinder, 117-horsepower, Model A-8, equipped with fluid coupling, serves as auxiliary engine. Auxiliary or deck engine power is transmitted through a four-speed, heavy-duty transmission, special right angle drive gear box, and chain drive to countershaft.

The chassis is a Harvester Model LF-192, while the engine is the six-cylinder model RD450, rated at 162 horsepower. Mixer on the 108-T is the conventional ICI vertical, ten-blade paddly type mechanical mixer, mounted at the rear of the truck and driven by the deck engine through dual V-belts. For flexibility of mixing and control of conveyor speed, the fluid driven conveyor is swivel mounted at the rear of the truck, and received power from deck motor through Vickers hydraulic pump and motor.

For additional information write International Cementers, Inc., 6505 Paramount Boulevard, Long Beach 5, Calif.

Worm and Gear Valve

This item supplements Homestead Valve Manufacturing Company data on pages 2258-2259 of Composite Catalog, 18th Edition.

Worm and gear operated valves have been added to the line of Homestead-Reiser lubricated plug valves. Identified as Figure 502 GW, the valves have "Self-Seald" construction, and a port area equivalent to 100 percent of the area of standard pipe. They are cast in semi-steel, and made in 8-, 10- and 12-inch sizes.

The valves will soon be available also in cast-steel, full-port type, to be known as Figure 562 GW; and in venturi type sizes up to 14 inches. In the venturi-type, the valves will have face to face dimensions identical to those of like-sized series 15 wedge gate valves, and will be designated as Figure 512 GW for semi-steel, and 572 GW for steel.

For additional information, write for Reference Book 39-5, Homestead Valve Manufacturing Company, P. O. Box 550, Coraopolis, Penn.

MAKE THE RIGHT MOVE

INSIST ON ALTEN SURFACE EQUIPMENT

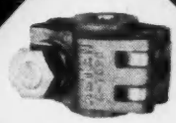
LUBRICATED STUFFING BOX

STUBBY TUBING HEAD

CLOVERLEAF STUFFING BOX

Alten equipment gives you deluxe features at rock bottom prices.

STOP COCK



WONBOLT POLISHED ROD CLAMP

It costs Alten far more to build equipment so that it costs you far less to operate and maintain it.

THE WORLD'S BEST PUMPING UNIT

Longest Strokes
Highest Gear Reducer Ratings
plus
Hardest Gear Surfaces

ALTEN

Pumping Units, Tubing Heads, Stuffing Boxes — every piece of equipment in the broad Alten line is fully performance proved. Get more for your money from the smallest Polished Rod Clamp to the largest Pumping Unit by asking your dealer to furnish Alten equipment.

ASK FOR COMPLETE ALTEN LINE
AT YOUR LOCAL SUPPLY STORE

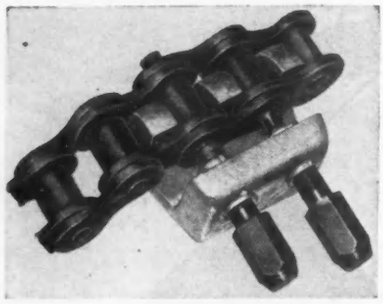
ALTENS FOUNDRY & MACHINE WORKS, INC.
LANCASTER, OHIO

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

Chain Repair Tool

This item supplements S. R. Bowen Company data on pages 781-820 of Composite Catalog, 18th Edition.



The Bowen Punch-Out Chain Repair Tool is made to withstand severe use and speeds dismantling or repairing roller chains. The tool eliminates the danger of steel splinters injuring workmen, and also prevents damage to chain that results from sledging.

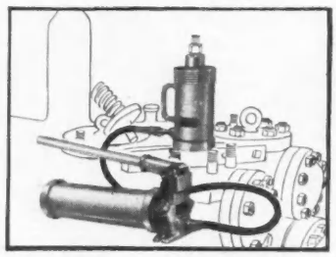
To operate the tool, the roller chain is placed in the body of the instrument. Tightening the bolts automatically center the bolts of the tool on the pins of the chain. Striking the heads of the bolts sharply with a hammer pushes the shouldered nuts and bolts forward and forces the pins of the chain through the links.

The tool is available for A.S.A. roller chains in normal pitch from ½- to 3-inch sizes, and for API roller chains in 3-, 3⅛- and 4-inch sizes.

For additional information write S. R. Bowen Company, Santa Fe Springs, Calif.

Remote Control Puller

This item supplements Templeton, Kenly and Company data on pages 4812-4813 of Composite Catalog, 18th Edition.



"Center-Hole" construction in new Simplex Re-Mo-Trol remote control hydraulic rams simplifies jobs such as pulling axles, shafts, pins and liners, by eliminating most of the rigging usually needed, the manufacturer claims. Tubular ram construction allows a center pulling screw or rod to be inserted through the center-hole and secured to the object to be pulled. As the ram plunger extends, the rod is drawn through the ram, which supplies its own back-up.

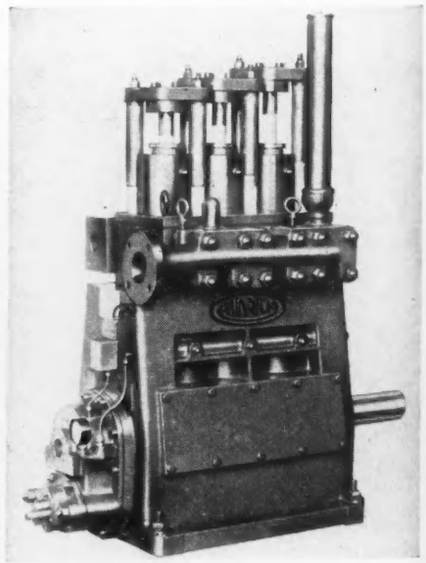
The units may also be used with pulling brackets and lateral pull rods, as well as for tightening cables and chains, lifting derricks, aligning pipe and shifting or leveling machinery.

The complete unit consists of pumps and rams, with necessary connecting hose. Capacities are from 10 to 100 tons.

For additional information, write Templeton, Kenly and Company, 1020 South Central Avenue, Chicago 44.

Triplex Pump

This item supplements The Aldrich Pump Company data on pages 164-165 of Composite Catalog, 18th Edition.



A three-inch stroke triplex, direct flow pump has been added to the Aldrich pump line. The triplex unit can operate at speeds up to 500 revolutions per minute, and has power ranges up to 50 horsepower, pressures up to 3800 pounds per square inch. Displacement capacity is up to 96 gallons per minute (3275 barrels per day) at 790 psi, 500 rpm.

The direct flow pump passes liquid in a straight line, directly through the working barrel. Elimination of two right angle turns in the fluid end block result in a reduction of "loss-space" in the fluid end. The fluid end is sectionalized in construction so that maintenance is simplified. Change in plunger size can be readily made to meet alterations in pressure or capacity.

For additional information write The Aldrich Pump Company, Allentown, Penn.

"The Greatest Name in Cable Tools"

Acme

TRUSTWORTHY SINCE 1900

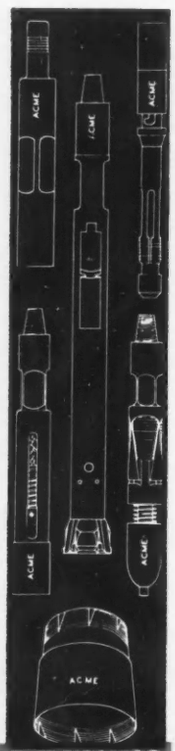
PETROLEUM EQUIPMENT SUPPLIERS' ASSOCIATION MEMBER

. . . to-be-Sure—Always Ask for Acme Sockets . . .

With a "yen" for toughest fishing jobs—hard jarring and all—Acme Combination Sockets help Drillers recover, quicker and surer, so called "hopelessly" stuck tools. Their distinctive design embodies ½-century's accumulated experience of our own fishermen; field specialists famous for meeting fishing problems.

From billet to finished tool, every field-service factor is rigidly observed: PREMIUM-grade steel; forgings CORRECTLY heat-treated; craftsmanship to detailed EXACTNESS. Acme Sockets have essential "built-in" design for extreme up-jarring, with least bursting stress: Correct spacing, depth, angle and super slip-wicker hardness. Also unique design of slips and slip-seat taper.

See Acme's Insert in 1951 Composite Catalog. Also write for more complete Catalog, containing valuable cable tool "use and care" manual.



Socket Slips

Fig. 208 — Acme Combination Socket. . . . 51-years' specialized "know-how" makes them worth more to YOU.

ACME DRILLING & FISHING TOOLS

ACME FISHING TOOL CO.
PARKERSBURG W. VA.
Export Office:
19 Rector St., New York 6, N.Y.

AVONDALE ... for the OIL INDUSTRY

You know what the word, "Integrity" means! Now apply it to a marine industry such as AVONDALE. It acquires many meanings, among which are: the absolute honesty of skilled experience, the "know-how" of people who understand and feel an interest in your particular problem. That's why AVONDALE has been so successful in building and repairing for the Oil Industry. . . . Integrity—all around!

Drilling Rig built for Rowan Drilling Company, Inc.

"Barnacle Bill", a radar-equipped crew boat designed for oil field work.

AVONDALE MARINE WAYS, Inc.

RIVER FRONT, NEW ORLEANS DISTRICT — MAIN PLANT, AVONDALE, LA.
Telephones: UNiversity 4561, CHestnut 5853 — QUICK-REPAIR PLANT, HARVEY, LA.
MAILING ADDRESS: WESTWEGO, LOUISIANA

---

the *where, when, how* and *why* of

PETROLEUM GEOLOGY

By KENNETH K. LANDES
University of Michigan

All the facts you want on oil and gas deposits—in one convenient place

Covering all the important aspects, this book combines geological occurrence, geographical distribution, and modern methods for locating oil and gas. Taking the *practical* approach, the author shows *how oil and gas are trapped* and *how these traps may be discovered.* Here the theories developed to explain the origin, migration and accumulation of oil and gas are effectively organized, synthesized, and critically evaluated. Giving the distribution of oil and gas fields all over the globe, the book also offers important information on possible hydrocarbon sources of the future.

1951 — 660 pages — 241 illus. — 6 by 9¼ — $10.00

For Sale By:

The GULF PUBLISHING Company
P. O. Drawer 2608 — Houston, Texas

SPECIAL DUTY SAFETY LIGHTS by JUSTRITE!

JUSTRITE

SAFETY EXTENSION LIGHT

Three cell operation. Flexible extension light. Retains curvature as you set it. Non-breakable clear plastic globe. Shock proof and spark proof. Choice of 15" or 30" extensions for inspection of all inaccessible areas.

FOUR CELL SAFETY HEADLIGHT — Model 1904-S

Case clips to belt and is connected to rubber padded headband with 48" plastic weatherproof cord. 1,500 foot beam. Underwriters Lab. approved for Class 1, Group D hazardous locations.

ORDER FROM YOUR JOBBER

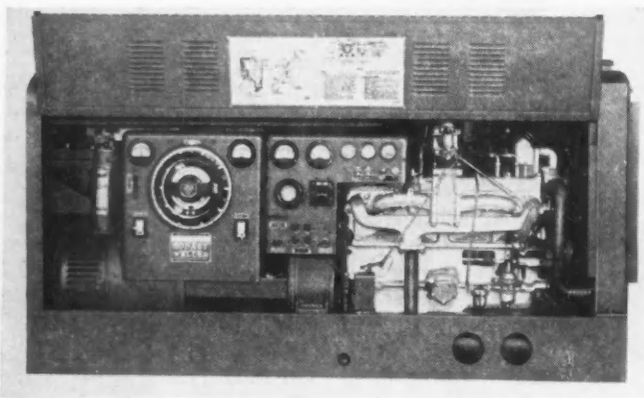
JUSTRITE MANUFACTURING CO.

FREE CATALOG
Write Dept. WO
2061 N. Southport Ave.
CHICAGO 14, ILL.

OTHER NEW AND IMPROVED EQUIPMENT

Arc Welder

A 300 ampere gasoline engine drive arc welder with a 3 kilowatt auxiliary power generator is a self-contained unit, completely enclosed by a sheet metal canopy bolted directly to the frame. Hinged side doors provide access to the control panels, the engine, the welding generator and other parts. The six-cylinder self starting Chrysler industrial engine is directly connected to the welding generator and mounted on a welded steel frame. The auxiliary generator provides for lights and such tools as a lathe, grinders, drills, brake reliner, valve refacer, chipping hammers, power wrenches, and paint sprayers.



For additional information write Hobart Brothers Company, Hobart Square, Troy, Ohio.

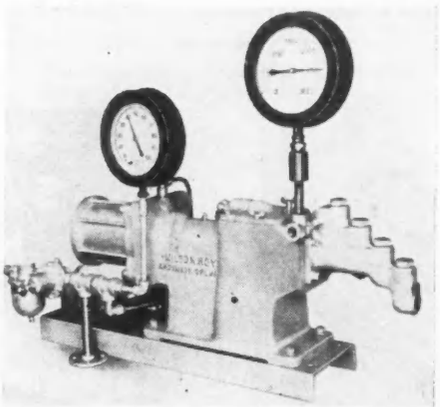
Steam Trap

The Velan Universal steam trap combines steam trap, air bypass valve, check valve, self-cleaning strainer, flow control glass, temperature indicator gauge, and temperature control in one unit. The trap can be installed in any position without affecting its efficiency, and in the vertical position is frost proof. The valve is opened by steam pressure and closed by thermal action, a new method of steam trap operation. On the outlet of the trap is a temperature gauge which shows the discharge temperature at all times. The discharge temperature can be regulated through a wide range.

For additional information write Velan Engineering Company, 1 Exchange Place, Jersey City, N. J., or 1216 Drummond Street, Montreal, Canada.

Pressure Generator

The "aiROYmetric" pressure generator, for hydrostatic test applications, is combined with a group of simplified controls to develop test pressures up to 25,000



pounds per square inch, using ordinary plant air supply in the pump cylinder. Each of the pumps develops a discharge pressure ratio range of at least 6 to 1, permitting single pump use for applications requiring various test pressures. Units can be made for specific applications between 25 psi and 25,000 psi. The generator is self-reciprocating, and in operation pumps continuously and automatically at maximum capacity in building up the desired pressure in the system. When a balance is reached between the air pressure and the corresponding hydrostatic test pressure, the pump automatically stops.

For additional information, write Milton Roy Company, 1302 East Mermaid Lane, Philadelphia 18.

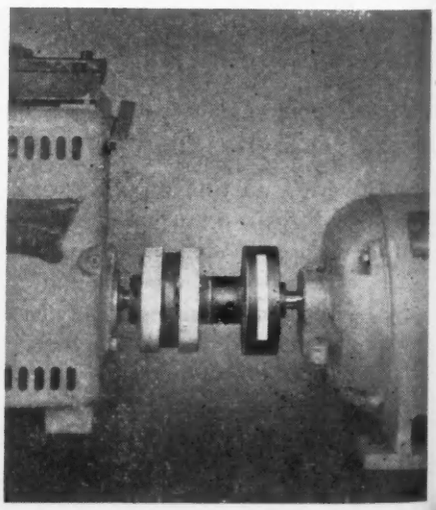
Flow-Regulating Valve

The Reynolds flow-regulating valve is a stop cock for use where an exact setting of the regulated flow of water, or other liquids, is required. It can be used as a flow-regulating valve for jet pumps and spray pumps; as a by-pass valve on boiler feed lines; or in any other place where a quick-opening stop cock or regulating valve is needed. The valve is of all-brass construction and has positive O-ring packing to prevent external leakage.

For additional information, write Reynolds-Shaffer Company, Department D-75, 12100 Cloverdale Avenue, Detroit 4.

Clutch Coupling

The Series "E" Mercury clutch coupling is a complete unit consisting of a Series "E" Mercury clutch with provision for mounting a standard flexible coupling between it and the driven load. It is designed for installation on the shafts of integral horsepower electric motors up to 15 horsepower rating. The unit used in conjunction with



a flexible coupling provides a connection between the motor shaft and the driven shaft without the necessity of maintaining exact alignment.

For additional information write for Bulletin 113, Mercury Clutch division, Automatic Steel Products, Inc., Canton, Ohio.

Put your Casing in the Right Hole!

Know for Sure - make a Johnston Test!

A string of casing represents quite an investment nowadays—and the next string may be even harder to get.

The Johnston Open Hole Tester will get information in your well—whether it is shallow or deep. This Tester's dependability has been proved in thousands of tests.

To know your well's productive possibilities—call Johnston when it is time to test. Experienced representatives operate in all active areas.

JOHNSTON OIL FIELD SERVICE CORP.

5702 NAVIGATION BOULEVARD HOUSTON, TEXAS

TEXAS—Houston, Beaumont, Alice, McAllen, Abilene, Cisco, Winters, Bowie, Gainesville, Graham, Jacksboro, Knox City, Throckmorton, Wichita Falls, Tyler, Victoria, Brownfield, Kermit, Midland, Odessa, San Angelo, Snyder. ARKANSAS—Magnolia. INDIANA—New Harmony. KANSAS—Great Bend, Liberal, Plainville, Pratt. KENTUCKY—Henderson. LOUISIANA—Lake Charles, Shreveport. MISSISSIPPI—Brookhaven. NEW MEXICO—Farmington, Hobbs. OKLAHOMA—Chickasha, Elk City, Healdton, Terry, Seminole.

M. O. JOHNSTON OIL FIELD SERVICE CORP.

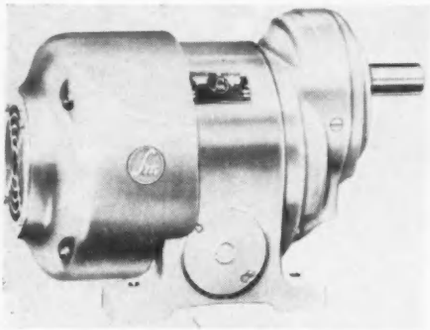
Servicing California, Rocky Mountains & Canada

FORMATION AND CASING TESTING
JOHNSTON

Geared Motor

A new "Slo-Speed" geared motor is of the single reduction, "Klosd-Tite" construction for atmospheres containing non-explosive dusts, vapors and injurious foreign materials. An external fan forces powerful cooling blasts of ar over the streamlined case. Output shaft ratings are the six AGMA speeds starting at 780 rpm down to and including 280 rpm. This new motor, type FWFA, is totally enclosed and includes labyrinth seals, heavy-duty lubricated ball bearings, and the Herringbone rotor.

For additional information write Sterling Electric Motors, Inc., 5401 Anaheim-Telegraph Road, Los Angeles.



JENSEN units grow old but do not fade away

When the years and the service-hours have made a JENSEN old, you don't junk it. It is still strong of limb and sound of heart. If parts are needed, you get them—fast!

In 30 years we have learned that any well is likely to be more profitable and certainly less trouble if JENSEN equipped.

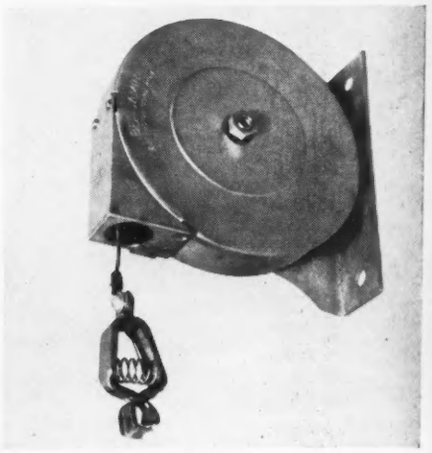
Ask the Jensen Dealer near you or write us for complete specification details and production records.

JENSEN Brothers
Coffeyville
Kansas

Export Office: 50 CHURCH STREET, NEW YORK CITY

Grounding Reel

Model 700-40-G0 Benjamin grounding reel, used in connection with the generation of static charges on fuel servicing equipment during the transfer of combustible fuels, holds the grounding cable off the ground to prevent its being entangled or damaged. The reel is equipped with 40 feet of 3/32-inch diameter cable. All parts are cadmium plated or are of rust-resisting material. There is uniform tension throughout the entire length of the cable when it is paid out. Where constant tension is not desired, the grounding reel can be provided with a ratchet arrangement, which latches the cable at intervals.



For additional information write Benjamin Reel Products, Inc., 10700-10710 Broadway, Cleveland 25, Ohio.

Pouring Aid

The GS easy-pour tilter No. 15 provides a safe and easy method of pouring liquids from cans into small containers. It is designed to prevent accidents caused by spilling, splashing and carelessness in pouring liquids. The cradle is made of steel, and fits any standard five-gallon can. All members are riveted or welded. The tilter can also be used for mixing liquids.

For additional information, write General Scientific Equipment Company, 2700 West Huntingdon Street, Philadelphia 32.

MEET THE BEAVERETTES!!!

• If you have not yet met the Beaverettes, it's high time you were introduced, for these handy little self-contained threaders have been favorites for many years.

The Beaverettes are unique — there is nothing similar to them on the market.

Covering a useful range of pipe sizes from 1/4 to 3/4 inches, the Beaverettes are fully adjustable for cutting standard, oversize or undersize threads of uniform length.

Complete units, having no loose parts of any kind, these tools are accurately centered on the pipe by a smooth-working universal chuck.

Beaver No. 6 is a two-handle non-ratchet tool; the No. 6-R, a standard one-handle ratchet tool, suitable for either bench or confined-area use. Both models are available in either American or British standards, right or left hand, for threading 1/4, 3/8, 1/2 and 3/4 inch pipe. Extra changeable dies are available for 1/8 inch size.

Write Beaver Pipe Tools, Inc., 254-300 Dana Ave., Warren, Ohio, for new "Operating Guide" to help you secure the best possible results from your Portable Pipe & Bolt Machines and Hand Pipe Tools.

BEAVER PIPE TOOLS

ALL OTHER FEATURES *plus* **TRAILER MOUNTING**

BOWEN POWERED SWIVELS *have*

- Greater Convenience
- Flexibility
- Protection

ELIMINATES

- Hand Rotation
- Fire Hazard
- Rotary Table And Auxiliary Equipment

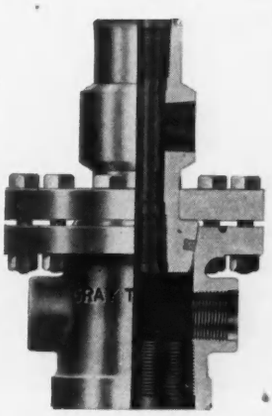
BOWEN POWERED SWIVELS
are used for all types of light rotary operations because they eliminate the necessity of moving in kellys, rotary tables or other heavy equipment for light, short time rotary work and because they eliminate the inefficiency and even danger of rotating strings by hand.
Bown Powered Swivels are available with or without trailer mounting. Trailer mounting provides the operator with conveniences of untold value and insurance against loss or damage to parts of the assembly.

Write For Complete Information

SR BOWEN CO
MAIN OFFICE AND PLANT:
11008 SOUTH NORWALK BOULEVARD
SANTA FE SPRINGS, CALIFORNIA
EXPORT OFFICE:
30 ROCKEFELLER PLAZA
NEW YORK CITY, NEW YORK
EXPORT REPRESENTATIVE, VAL R. WITTICH, JR.

FOR
STRENGTH
WHERE IT'S NEEDED MOST
USE STEEL FORGINGS
BY
BEAUMONT WELL WORKS

Beaumont Well Works is equipped with the tools and the know-how to strengthen your product and reduce your manufacturing costs with forgings. Carbon, alloy, and stainless steel forgings made to your specifications will help reduce your costs of manufacture and will put more sales appeal in your product. Now, without investing a cent in forge equipment, you can compete successfully with the largest manufacturers of oil field equipment. Investigate the advantages of steel forgings, then call on Beaumont Well Works for specific engineering and manufacturing information concerning your product.



An example of the strength and safety built into a product by Beaumont Well Works Forgings.

BEAUMONT

WELL WORKS COMPANY
INCORPORATED
BEAUMONT, TEXAS

Drilling Equipment

The complete line of "Streamline" oil well drilling and servicing equipment is described in a new catalog. The line included complete mobile integrated drilling rigs, with all component parts of power plant, drawworks, rotary drive and telescoping derrick with strung-up block and hook mounted on one trailer; complete dual engine, dual mud pump unit mounted on a second trailer; and all drilling accessories such as rotary table and base, platforms, mud tanks, shale shaker, etc., on a third trailer or truck.

For a copy of this catalog, write Wagner-Morehouse, Inc., 5909 Randolph Street, Los Angeles.

Cold Separation

A 50-page technical book by J. D. Lowd, sales manager of the Pressure Vessel division of Parkersburg, explains the theory and practical application of "cold separation." The book, "Basic Application Procedures for Hyreco Processing Units," treats basic principles in question-and-answer form.

For a copy of this book, write The Parkersburg Rig & Reel Company, Parkersburg, W. Va.

Eagle-Picher Lead Wool

STOPS

bottom water

Rule out the risk of oil-wasting bottom water shutdown by tamping Eagle-Picher Lead Wool in the hole. The finely stranded, flexible metallic wool makes a water-tight plug that seals every crack and crevice. Comes in convenient 50-pound sacks—easy to place in special cartridge-shaped Eagle-Picher Wire Containers sized to fit all casings. Order through your jobber.

THE
EAGLE-PICHER
SALES COMPANY
Since 1843

Metallic Products Division,
General Office, Box 777
East Chicago, Indiana

Cincinnati • Kansas City
East St. Louis • Dallas • Houston

Member: Lead Industries Association

2068-LW

EAGLE EP PICHER

These **3** *Eagle-Picher Bearing Metals meet most requirements*

1. **Dreadnaught** — for extreme speed and heavy-duty conditions.
2. **Outlasta** — for medium speed and average-load conditions.
3. **Durable** — for low speed and light-duty conditions.

Drilling Rig

Ideal Type T-20 drilling rig, a 200-horsepower rig for shallow drilling, medium depth servicing and workover jobs, is described in a new eight-page bulletin which illustrates rig design and construction, operation and controls, and gives specifications, performance chart, dimensional drawings and drive arrangement diagram.

For a copy of Bulletin 375, write The National Supply Company, Box 899A, Toledo, Ohio.

Safety Head

A new 52-page, two-color catalog on safety heads contains charts and tables covering many phases of safety head information, as well as non-technical discussions, and illustrations.

For a copy of the bulletin, write Black, Sivalls & Bryson, Inc., Advertising and Sales Promotion Department, 7500 East 12th Street, Kansas City 3, Mo.

Chain Drive

Hy-Vo power transmission drives are the subject of a new catalog which includes a basic discussion of operating principles behind chain drives, highlights of Hy-Vo design, description of what the drive will do in the field of high-speed, heavy-duty power transmission, Hy-Vo capacities, and installation procedures.

For a copy of Catalog C 72-51, write Morse Chain Company, 7601 Central Avenue, Detroit 8.

Meters for Water Flooding

A six-page bulletin describes Rockwell Five Pointer meters, for use in areas where oil is produced by water flooding or oil repressuring. Both disc and piston design principles are illustrated in the folder, which includes full specifications.

For a copy of Bulletin OG 351, write Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh 8.

Channeling Acid

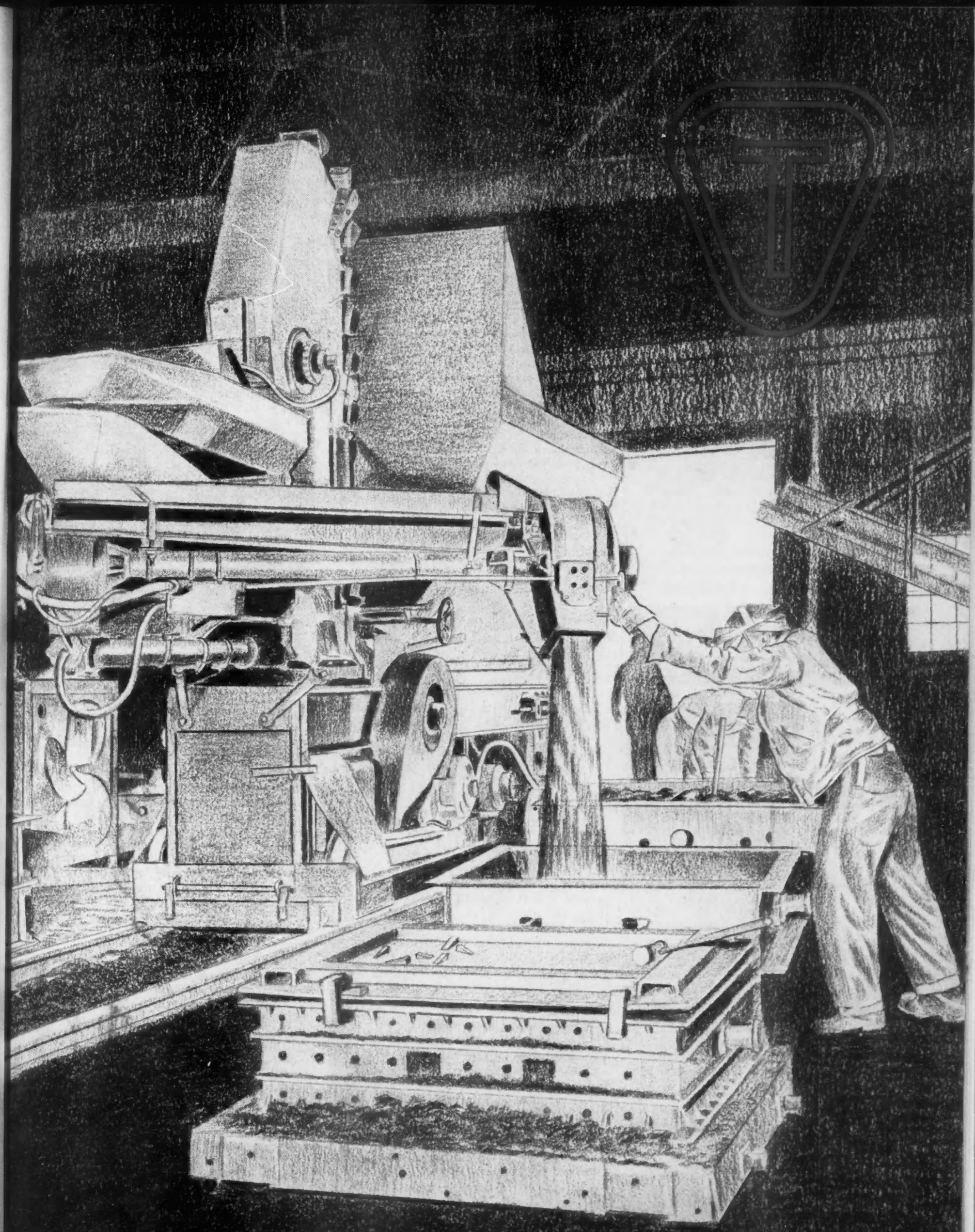
An AIME reprint of a paper by P. H. Cardwell, chief chemist for Dowell Incorporated, "Improvement of the Acidizing Process by the Formation of Channels," is available in booklet form. In addition to a technical discussion of Channeling Acid, the booklet also describes other Dowell chemical services.

For a copy of this booklet, write Dowell Incorporated, Department P, P. O. Box 536, Tulsa 3.

Oil Field Assembly Chains

"Oil Field Assembly Chain" is the subject of a new Whitney catalog which provides complete engineering reference tables on roller chains from ⅜-pitch too 2½-inch, in single and multiple widths. It also supplies data on flexible couplings and Jeffrey chains for oil field service.

For a copy of this catalog, write Whitney Chain Company, 237 Whitney Street, Hartford, Conn.



Modern production methods, backed by years of experience, make TESCO your most dependable source of steel castings.

TEXAS ELECTRIC STEEL CASTING CO.

GOOD CASTINGS TESCO HOUSTON, TEXAS

L-O-N-G-E-R
THREAD LIFE

1. EXCLUSIVE 500-TON SPECIAL prevents washouts and galling. Makes breaking out easier; withstands highest pressures, and is unaffected by heat and moisture!
2. KANT-GALL TOOL JOINT COMPOUND
3. LONG-LIFE DRILL COLLAR COMPOUND

SOLD BY SUPPLY STORES EVERYWHERE

PETROLEUM DISTRIBUTING CO.
BOX 203—HOUSTON, TEXAS
CHarter 5648

STITT®

SINCE 1918 · THE STANDARD
GAS ENGINE SPARK PLUGS

Quality construction features for reliable performance in natural gas engines . . . means less "shut down" time! New Stronger Insulator has higher heat conductivity . . . Less Fouling under any condition . . . Special Alloy electrodes and ground wire construction insure longer life.

For SOUR gas specify X series . . . there's a STITT plug for every engine

at your supply stores EVERYWHERE

Inquiries Invited . . . write
STITT Ignition Co., 86 E. First Ave., Columbus 1, Ohio

Men in the Industry NEWS

Dr. Karl C. ten Brink, former instructor at Rice Institute, Houston, who has been with The Texas Company since 1947, has been promoted to assistant director of producing research, Bellaire Laboratories. After receiving his Ph.D. in chemical engineering at Rice, Dr. ten Brink served as an instructor there from 1940 to 1943. He was in the Navy three years, then returned to the Institute. He joined The Texas company in 1947 as a chemical engineer at Bellaire.

V. M. Grant, assistant division supervisor of industrial relations, Oklahoma division, Producing department, The Texas Company, has been named division supervisor of industrial relations, Rocky Mountain division, and transferred to Denver. He replaces **S. F. Chamberlin,** who has been recalled into military service.

Grant, a graduate of Northeastern State Teachers College, Tahlequah, Okla., was employed by The Texas Company at Tulsa in 1937. He is succeeded as assistant division supervisor of industrial relations in the Oklahoma division by **E. L. Taylor,** formerly head payrool clerk. Taylor is a graduate of Tulsa University and has been with the company since 1939.

•

Frank O. Prior, vice president in charge of production, a member of the executive committee, and a director of Standard Oil Company (Indiana), has been elected executive vice president. Prior entered the oil business in 1919, and rose to the presidency of Dixie Oil Company, a former Standard subsidiary. In 1930 he was made president of Stanolind Oil and Gas Company, when that company was formed through the merger of Dixie and other producing subsidiaries of Standard of Indiana to carry on oil producing operations. He was elected a director and vice president of Standard in 1945.

•

Colbert H. Marshall has been elected vice president of Ashland Oil & Refining Company in charge of crude production and related operations. Marshall, who had previously been with an Oklahoma refinery in an executive capacity and also an independent producer, joined Allied Oil Company and its subsidiary, Central Pipeline Company, in 1942. Since their merger with Ashland in 1948, he has been general manager of Ashland's crude oil procurement, production and pipeline operations in the Southwest. His offices are in Oklahoma City.

C. H. Marshall

•

Burr M. Roberts has been appointed geologist in charge of Bishop Oil Company's new field office at Scottsbluff, Neb. Roberts recently returned to the U. S. from the company's operations in the Redwater field of Alberta, Canada. The Scottsbluff office is at 1818½ Broadway.

E. B. Redpath

C. A. Jackson

H. H. West

F. L. Fox

E. B. Redpath, secretary of The Ohio Oil Company since 1928, has been elected executive vice president. **H. H. West,** formerly assistant to the president, was elected secretary, and **C. A. Jackson,** assistant comptroller, was named assistant to the president. **F. L. Fox,** assistant secretary, was elected a vice president.

Redpath joined the company as a messenger at Oil City, Penn., in 1905, and in 1906 became secretary to the treasurer. He moved to Findlay, Ohio, in 1907 when the headquarters were moved there, and in 1916 was transferred to Wichita, Kan., as division comptroller of the Mid-Kansas Oil and Gas Company, a subsidiary. He returned to Findlay and was appointed assistant secretary in May, 1919, a position he held until May, 1928, when he was elected secretary. He has been a director since May, 1932.

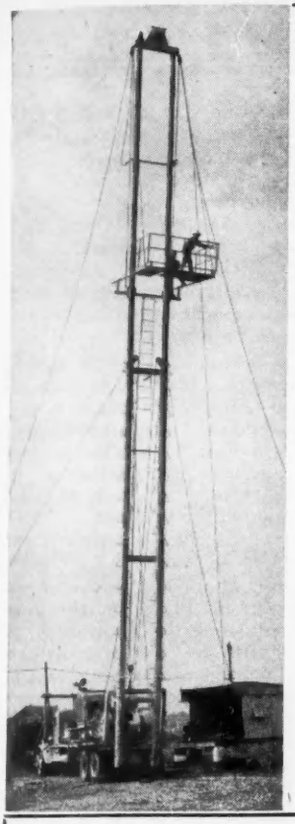
West joined the company in 1922 as a stenographer, and advanced through various departments and positions to the post of assistant to the president in 1941. He has been assistant secretary since 1948.

Jackson, a graduate of the University of Illinois, joined The Ohio in 1932 at Robinson, Ill., and was transferred to Findlay in 1935. He was named assistant comptroller in 1943.

Fox, who joined the company in 1915, has been supervisor of the Title and Lease Records department, as well as assistant secretary, since 1947.

•

Paul W. McFarland has been promoted to assistant chief geologist for Sun Oil Company's Southwest Producing division, Dallas. He will continue as regional geologist in charge of the San Antonio, Corpus Christi and McAllen districts. A graduate of the University of Kansas, McFarland joined Sun in 1923 and served about two years in Venezuela. After returning to the U. S., he worked at Tulsa and Laredo, Texas, before going to Dallas in 1929.



S&R

Custom Built

PORTABLE TELESCOPING POLE MASTS—

This S & R double ladder mast is of heavy welded steel construction, and is fabricated of 10¾" pipe and 8⅝" pipe. Overall dimensions when erected 87 feet to crown support beam and 52' when telescoped in traveling position.

Approximate weight of the complete equipment is 12,000 lbs. The complete assembly includes the (1) poles, (2) breakdown shaft assembly, (3) attached racking platform (which positions itself when poles are raised), (4) pole adjusting screws, (5) a sheave assembly to be mounted on truck or trailer for raising the poles, (6) and a four or five 24 inch sheave crown block for ⅞" line.

Available for truck, trailer, or skid mount.

For additional information write, wire, or phone.

S & R TOOL & SUPPLY CO.
P. O. Box 1755 155 McCarty
HOUSTON 1, TEXAS
Export: 233 Broadway, N. Y. 7, N. Y.

S&R TOOL — SUPPLY CO. HOUSTON, TEXAS

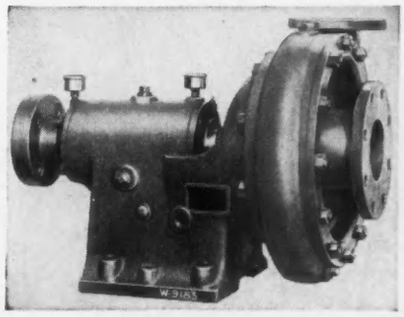
WORTHINGTON "WORTHITE"

SALT WATER PUMPS

For Longer Life and Dependability

WE OFFER

The Worthington Type "CG" all Worthite 20-24% Chrome Nickel Steel Centrifugal Pump for Electric Motor or Gasoline Engine Drive



Available for Stock shipment thru Our Distributors

A. M. LOCKETT AND CO., LTD.

HOUSTON NEW ORLEANS DALLAS

PETROLEUM PRODUCTION

Volume I. The Mechanics of Production: Oil, Condensate Natural Gas

By PARK J. JONES, Consulting Engineer, Houston, Texas

The first of a series of five volumes dealing with the application of the basic engineering principles of drilling oil wells and extracting the oil most efficiently and economically. Presented by a nationally known authority, formerly with The Texas Company, the information is highly practical, and is detailed, specific, and thoroughly documented. The treatment is as clear, concise, and simple as possible, and the explanatory matter is illustrated by extensive use of graphs.

231 pages Illustrated $5.00

Volume II. Optimum Rate of Production

This is the second in a series of five volumes which will comprise the most thoroughgoing treatment of the engineering aspects of petroleum production ever presented. Contents include: The Maximum Efficient Rate of Production; Oil, Condensate and Natural Gas Reserves; Well Producing Capacity for Reservoirs; Interest Factors; The Period of Development; Uniform Rates of Production; Uniform Rates of Depletion; Economic Limits for Wells and Reservoirs; Increasing Rates of Depletion; Decreasing Rates of Depletion; The Optima for Uniform Rates of Depletion; The Optima for Variable Rates of Depletion; Exponential Functions; Natural Logarithms. 295 pages, $5.00

Volume III. Oil Production by Water

Third volume deals with the application of the basic engineering principles of drilling oil wells and extracting the oil most efficiently and economically.

275 pages Illustrated $5.50

Volume IV. Condensate Production and Cycling

Contents include: Condensation in Reservoirs; Injection into Rich Gas; Injection into Water; Production by Expansion; Displacement and Expansion; Economics of Condensate Production; Radial Reservoirs; Elongated Reservoirs; Linear Reservoirs; Maximum Efficient Rate.

239 pages Illustrated $5.50

Volume V. Oil Production by Gas and Flooding

Contents: Preface. Part I. Foundations; Reservoir Characteristics; Displacement of Oil by Gas; Separation and Plant Extraction; Vaporization in Oil Reservoirs; Pressure Maintenance with Gas; Declining Reservoir Pressure; Oil Recoverable by Flooding. Part II. Oil Production by Gas; Radial Reservoirs and Traps; Linear Reservoirs and Traps. Part III. Oil Production by Flooding; Economics of Flooding. Appendix. Tentative K Values for Oil. Index.

280 pages Illustrated $6.00

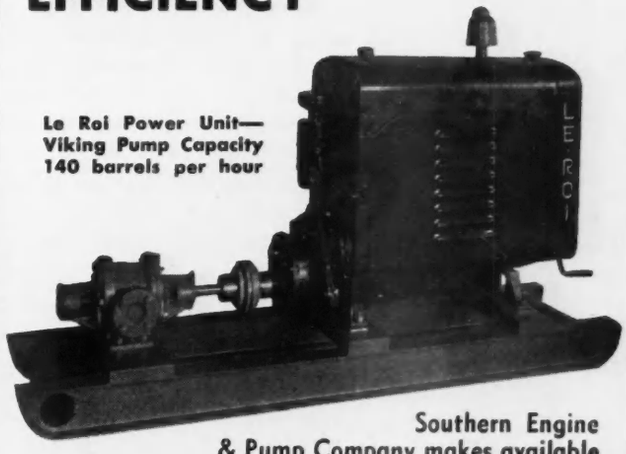
"Prices subject to change without notice"

Send orders to

THE GULF PUBLISHING COMPANY
P. O. Box 2608, HOUSTON 1, TEXAS

THE RIGHT TEAM FOR EFFICIENCY

**Le Roi Power Unit—
Viking Pump Capacity
140 barrels per hour**



Southern Engine & Pump Company makes available to you 40 years of "KNOW HOW" in your pumping requirements.

• Complete units and replacement parts at all branches.

SOUTHERN ENGINE & PUMP COMPANY

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS
Houston - Dallas - Kilgore - San Antonio - Edinburg
Corpus Christi, Texas· Houma and Lafayette, La.

R. C. Barbour has been appointed manager of the Production department of Humble Oil & Refining Company, Houston, and will be active head of all production operations, reporting to the director in charge, **C. E. Reistle, Jr.** Humble has also created two training positions to be occupied by assistant managers who will serve on a rotating basis, on tours of one year each. **Bowman Thomas**, former chief petroleum engineer, will be assistant manager in charge of all staff organizations of the department. **R. R. McCarty**, who has been assistant division superintendent in Southwest Texas, will head drilling and producing operations. Also as part of the training program, **Douglas Ragland**, former assistant chief petroleum engineer, will become chief petroleum engineer to replace Thomas.

R. C. Barbour

Bowman Thomas

R. R. McCarty

Barbour joined Humble in 1921 and in 1923 was made district superintendent of Powell oil field. After eight years at this post, he was appointed assistant division superintendent in East Texas. He became West Texas division superintendent in 1934, and was transferred back to East Texas as division superintendent in 1936. In 1946, he became general superintendent of the Production department.

Thomas joined Humble as a junior petroleum engineer in 1929, shortly after being graduated from the University of Oklahoma. In 1940 he was promoted to assistant chief petroleum engineer, and in 1945 was named chief petroleum engineer in the Production department.

A graduate of Louisiana State University, McCarty joined Humble as a student engineer in 1930 and worked in several oil fields before his appointment, in 1934, as assistant district superintendent of the Andrews district. In 1942 he was named district superintendent of the Chalkley district in Louisiana, and was transferred the next year to Avery Island, in the same capacity. He was appointed to his most recent position, assistant division superintendent of the Southwest Texas division, with headquarters at Corpus Christi, in 1946. **T. J. Fuson**, division petroleum engineer, Gulf Coast division, became assistant chief petroleum engineer, replacing Ragland. **H. M. Krause, Jr.**, assistant division petroleum engineer, Louisiana division, replaced Fuson as division petroleum engineer of the Gulf Coast division. **Joe F. Homer**, supervising petroleum engineer, was named assistant division petroleum engineer, Louisiana division, to replace Krause.

W. F. Barrett, district superintendent, Government Wells district, will serve temporarily as assistant division superintendent of the Southwest Texas division, relieving McCarty.

William A. Castille, assistant division civil engineer, Louisiana division, transferred to the Civil Engineering division, Houston office, for work as senior supervising engineer during the absence of **L. O. Zapp**, who is on leave for a government assignment.

Richard J. Lee, senior petroleum engineer, Houston office, was transferred to the Willamar district, Southwest Texas division, as district petroleum engineer.

•

Lawrence Skelley, geologist with the Houston Oil Company of Texas, has resigned to open consulting offices at 505 Milam Building, Houston, and will specialize in the geology of South Texas and the Gulf Coast. A graduate of the University of Texas, Skelley has been with Houston Oil for the past five years, four of which he spent in South Texas and one in the home office at Houston.

GRANT VERTICAL CASING SCRAPER

THREE SETS OF CUTTERS are held in expanded position against the casing circumference by means of heavy springs . . .

CUTTERS ARE SPACED so as to overlap in their contact with the casing, provide the most effective and efficient cutting action, give better fluid return path . . .

HELICAL DESIGN of the hard-faced cutting edges provides an efficient shearing-cutting action that completely removes burrs and foreign material from the casing wall . . .

FOOL-PROOF LOCK holds cutters securely, yet cutters can be quickly changed in the field when worn.

EITHER TUBING OR WIRE LINE can be used for running the Grant Vertical Scraper, and full circulation can be established through the tool if necessary.

See your nearby Grant Representative for details . . . write for Bulletin 59, or see your 1951 Composite Catalog.

Proven Grant Tools—Used Where Performance Counts

	Bulletin No.
Hydrostatic Bailers	11
Liner Pullers	14
Pressure Releases	15
Hydraulic Expansion Casing Scrapers	17
Rotary Underreamers	24
Cable Tool Underreamers	27
Hole Enlargers	38
Reamers	43
Hydrostatic Perforation Cleaners	50
Dump Bailers	51
Roller Cutter Shale Bits	54
Sand Pumps	55
Well Cleanout Equipment	57
Wall and Bottom Hole Scrapers	58
Vertical Casing Scrapers	59

Write for Descriptive Bulletins on these Grant Tools

GRANT OIL TOOL COMPANY

Main Office and Plant
2042 E. Vernon, Los Angeles 11, Calif.
Branches Throughout California and The Mid-Continent

Subsidiary: MacClatchie Manufacturing Company

MEN IN THE INDUSTRY NEWS

L. A. Wainwright

T. A. Bowles, Jr.

L. A. Wainwright has been elected president and a director of Rycade Oil Corporation, Houston, and **Thomas A. Bowles, Jr.**, has been elected vice president.

Wainwright joined Rycade in 1947, after having been with Amerada Oil Company for 20 years.

Before joining Rycade, Bowles was with Sohio Oil Company for seven years as superintendent of the Land department.

•

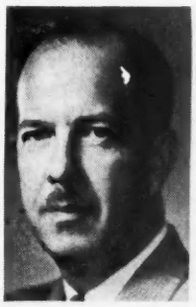
C. J. Montgomery, Jr., has resigned from Tide Water Associated Oil Company to establish an office in Houston to practice as a consulting engineer and surveyor. Montgomery, a registered engineer in Texas and Louisiana, will specialize in civil engineering and title surveying, as they pertain to the oil industry. He joined Tide Water's Civil Engineering department in 1935, and at the time of his resignation was assistant to the chief civil engineer.

C. J. Montgomery, Jr.

•

W. T. Stevenson has been elected president of Texas Gas Transmission Corporation. **J. H. Hillman, Jr.**, formerly president and chairman of the board, will continue as chairman of the board.

Stevenson has been executive vice president and director of Texas Gas since the company was formed in 1948. He was also an officer and director of the two predecessor companies of Texas Gas, Kentucky Natural Gas Corporation and Memphis Natural Gas Company, which were merged with and into Texas Gas in 1948.

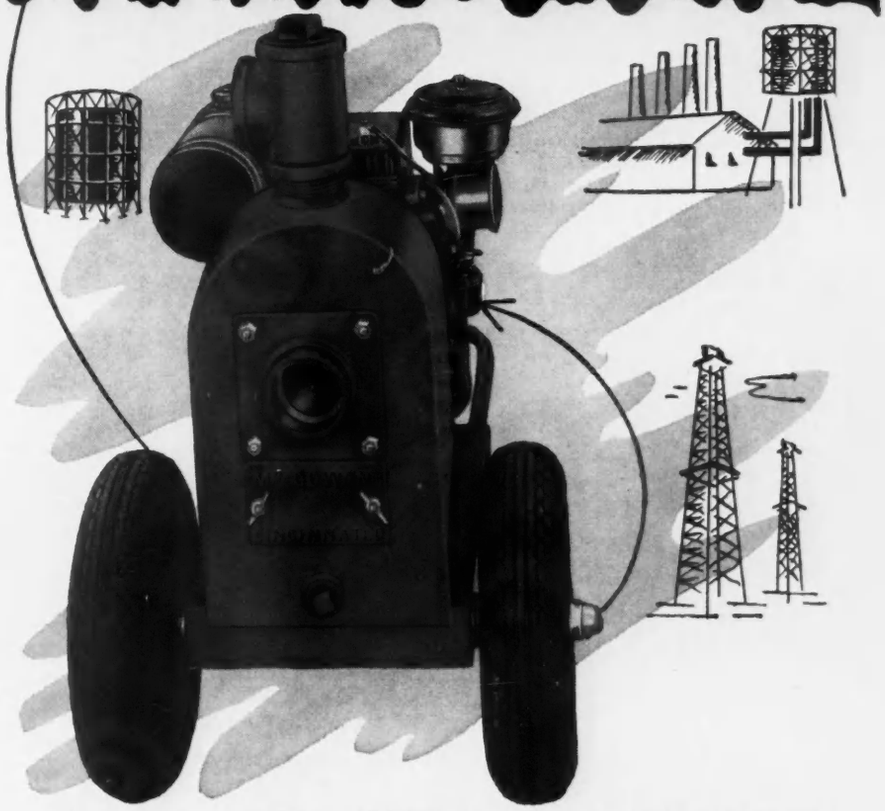


W. T. Stevenson

•

A. K. Cline, Marietta, Ohio, independent oil operator and producer in the Pennsylvania grade area, has joined Seminole Oil & Gas Corporation as operations manager. The company has moved its offices from Dallas to the new Allen Building in Midland, Texas.

BEST for OIL FIELD JOBS



McGOWAN

SELF-PRIMING CENTRIFUGAL OIL PUMPS

McGOWAN PUMPS are in operation in Oil Fields all over the world — backed by the reputation and integrity of a Company that has been building Pumps since 1852. McGOWAN PUMPS are unequalled for ruggedness, durability and the ability to do the job — BETTER — MORE ECONOMICALLY.

They feature AUTOMATIC PRIMING — SYNTHETIC RUBBER GASKETS AND SEALS — LARGE ACCESS PLATES. Can be furnished with electric or belt drive.

McGOWAN PUMPS are available at your Supply Co. Complete information can be furnished by writing or calling McGowan Pump Co., Central Ave., Cincinnati, Ohio.

SINCE 1852 McGOWAN PUMPS

McGOWAN LEYMAN MANUFACTURING CORP. PUMPS

58 CENTRAL AVE., CINCINNATI 2, OHIO

McGOWAN PUMP DIV., Leyman Mfg. Corp.
58 Central Ave., Cincinnati 2, Ohio
Please send without obligation data on McGowan self priming centrifugal pumps.

COMPANY_____

NAME_____

ADDRESS_____

Sam M. Gladney has been appointed manager of Sun Oil Company's Southwest Producing division and has been succeeded as assistant manager by **Tom F. Hill**, formerly regional land superintendent.

Gladney succeeds **J. H. Pressley**, who has relinquished all managerial and official capacities with Sun because of illness. Pressley has been with Sun since 1905.

Gladney joined Sun in 1919 as a clerk in the Accounting department at Dallas, and was advanced through various positions to superintendent of production for North Louisiana and Arkansas. In 1930 he became district land superintendent at Tyler, Texas, and in 1939 he returned to Dallas as manager of the Land department, a position he held until his promotion to assistant manager of the Southwest division in 1947.

Sam M. Gladney

Tom F. Hill

Hill joined Sun 20 years ago as a sample washer in the paleontology laboratory in Dallas, while still a student at Southern Methodist University. He was later field geologist and scout at Corpus Christi, and became assistant district land superintendent in 1946. Two years later he was named a division landman at Dallas, and last year became assistant to Gladney.

•

V. H. King has been appointed to the newly created position of manager of General Petroleum Corporation's Exploration department. In his new post King will be responsible for the coordination and correlation of all activities of all divisions of the department. Formerly supervisor of exploration in the Rocky Mountain district, he will now make his headquarters in Los Angeles.

K. A. Gorton, former assistant supervisor of exploration in the Rocky Mountain district, will replace King as supervisor of exploration, Rocky Mountain division. His offices will continue to be in Casper, Wyo.

K. A. van der Weg and **P. H. Gardett** have been promoted to positions in Los Angeles. Van de Weg advances to the post of supervisor of geophysics, Los Angeles, from the same position in the Rocky Mountain division, at Casper. He replaces **N. R. Shade**, retired. Gardett is the new assistant supervisor of exploration, California division. He formerly was district geologist, Los Angeles Basin.

A. G. Alpha advances from district geologist, Montana, to regional geologist, with offices in Casper.

F. R. Reeves takes over the position of geophysicist, Rocky Mountain division. Reeves, formerly with Western Geophysical Company, will make his headquarters in Casper.

•

Dr. Paul D. Foote, vice president of Gulf Oil Corporation in charge of research and development, was presented with the Outstanding Achievement Medal Award of the University of Minnesota at Minneapolis. The honor is reserved for former students who have attained high eminence and distinction.

Dr. Paul D. Foote

Dr. Foote, who received his Ph.D. in Physics from the University in 1917, has played a leading role in developing the Gulf laboratories at Harmarville, Pa., into one of the nation's major industrial research centers.

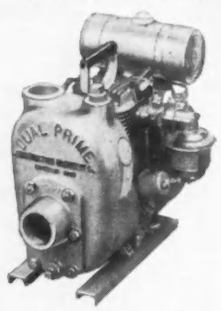
•

Herbert A. Gidney, who has been associated with The Gulf Companies more than 31 years, has retired from all official positions. He has been a member of the board, executive vice president, a member of the Executive Committee, Finance Committee, and numerous other management and employe benefits committees. Gidney joined Gulf in January, 1920, as chief accounting officer.

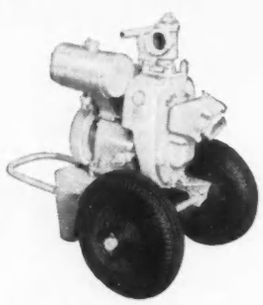
CMC

DUAL PRIME AND STRAIGHT CENTRIFUGAL PUMPS

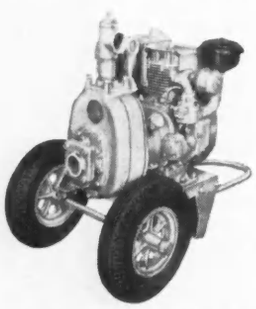
Include
CLOSE-COUPLED CONSTRUCTION
SELF-ADJUSTING ROTARY SHAFT SEALS
HYDRAULICALLY BALANCED IMPELLERS



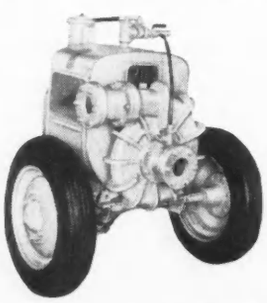
MODEL 21 2" PUMP 1 H.P.
DUAL PRIME
25 GPM @ 27 PSI 60 GPM @ 17 PSI



MODEL 24 2" PUMP 4 H.P.
DUAL PRIME
50 GPM @ 39 PSI 125 GPM @ 30 PSI



MODEL 2H7 2" PUMP 7 H.P.
DUAL PRIME HI-HEAD
30 GPM @ 100 PSI 60 GPM @ 69 PSI



MODEL SS3H25 3" PUMP 25 H.P.
PRESSURE-FLO
200 GPM @ 122 PSI 400 GPM @ 70 PSI

FOR INFORMATION ON OTHER MODELS OF THE EXTENSIVE CMC LINE OF PUMPS, CONTACT YOUR NEAREST CMC SUPPLY STORE OR . . .

3340 Dixie Drive • Houston 21, Texas • Phone: Linden 3988

Construction Machinery Co's. Waterloo, Iowa

MEN IN THE INDUSTRY NEWS

B. C. Adams, Jr.

E. T. Bowers

B. C. Adams, Jr., has been elected vice president of Texas Gas Transmission Corporation in the Gas Supply department, and **Edward T. Bowers** has been elected comptroller of the corporation.

Adams has been assistant to the executive vice president since he joined Texas Gas in May, 1950. In addition to his duties of negotiating and contracting for natural gas reserves, he will continue as vice president of Louisiana Natural Gas Corporation and Texas Northern Gas Corporation.

Bowers, who has been assistant comptroller of company, has been with Texas Gas and a predecessor company, Memphis Natural Gas Company, since 1940.

•

James R. Puckett has been promoted from district petroleum engineer of Magnolia Petroleum Company's Kermit Producing district to division petroleum engineer of the Kansas-Illinois-Kentucky division with headquarters at Wichita, Kansas. Puckett replaces **John R. Van Slyke** who has resigned to enter business for himself.

H. K. Holland has been promoted from assistant division petroleum engineer of Magnolia's Gulf Coast division at Houston to division engineer of the Oklahoma division with headquarters at Oklahoma City. He replaces **Henry L. Waszkowski**, who has been made assistant superintendent of the Healdton Producing district.

Dee F. Pendley, Jr. has been promoted from a petroleum engineer of the Kermit district to district petroleum engineer of Electra Producing district. **Robert W. Lewis, Jr.** has been promoted from district petroleum engineer of the Falfurrias district to assistant division petroleum engineer of Magnolia's West Texas division with headquarters at Midland, Texas. **Robert C. Randle** has been promoted from a petroleum engineer of the Falfurrias district to district petroleum engineer in the same district.

Ollie J. Ford, Jr., district petroleum engineer of Magnolia's Rusk Producing district in East Texas has been transferred to the same position in the Kermit Producing district. **Joseph A. Morris** has been promoted from a petroleum engineer in the Alice Producing district to district petroleum engineer of Magnolia's Rusk Producing district with headquarters at Kilgore, Texas.

•

R. R. Anderson, formerly of Sun Oil Company's Morganfield, Ky., production district, has been named assistant to the manager of the Michigan division Land department, with offices in Toledo, Ohio.

N. E. Anderson has been named to the new post of assistant office manager of the Dallas office.

Meet Your "No. 1" FREIGHT INFORMATION MAN

Your Santa Fe Freight Representative knows the answers to your problems

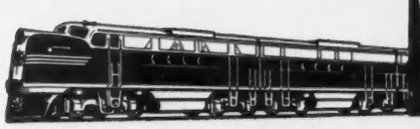
Your Santa Fe freight representative is a professional "answer man," with ready access to the collective information, knowledge and "know-how" of Santa Fe's entire organization of transportation specialists.

He is either in your town, or has your town assigned to him. Either way, he is no further away than your telephone.

Call on him freely for expert advice on your shipping problems. Find out why *it pays to ship Santa Fe all the way.*

F. H. Rockwell, *General Freight Traffic Mgr.*
Santa Fe System Lines, Chicago 4, Illinois

Santa Fe—all the way



Santa Fe

Seven GOOD Reasons Why

You Get.....

- **Smoother Performance,**
- **Longer Life,**
- **Better Service with**

WECO Drop Side*

Snatch Blocks!

1. **FORGED STEEL HOOK** — Full swiveling . . . extra strength . . . blunt tip . . . straight-line pull.
2. **DROP-SIDE*** — Fast, easy stringing, without using end of line. Hinge plate secured with acme thread wing nut.
3. **REGISTERED** — Individual serial numbers assure registered quality.
4. **SNARL-PROOF** — Line can't bind between sheave and shell, or sheave and hook assembly.
5. **CASE HARDENED SHEAVE PIN** — Greater resistance to wear; accurately ground to size.
6. **SUPER OILITE BEARING** — Accurately "sized" for precision fit and even load distribution.
7. **FORGED STEEL SHEAVE** — Precision machined . . . gaged to new wire rope dimensions for longer rope life.

* Patented

WECO

WELL EQUIPMENT MFG. CORP.

Subsidiary of Chiksan Company
HOUSTON 1, TEXAS
Exclusive Sales Representative Outside Mid-Continent Area
CHIKSAN COMPANY
Brea, Calif. Chicago 3, Ill. Newark 2, N. J.
Export Sales: CHIKSAN EXPORT COMPANY, Brea, Calif. Newark 2, N. J.

Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

MEN IN THE INDUSTRY NEWS

Burl S. Watson

Emil Schram

Burl S. Watson has been elected executive vice president and **Emil Schram** has been elected a director of Cities Service Company.

Watson, a graduate of the University of Alabama with a degree in electrical engineering, has been with Cities Service since 1917. For many years he was assistant to **W. Alton Jones**, president, and became a vice president in 1940.

Schram, former president of the New York Stock Exchange, was at one time chairman of the board of the Reconstruction Finance Corporation.

•

R. L. Keyes of New Orleans has been promoted to assistant manager of the Producing department, The Texas Company, and transferred to the general manager's office, Houston. He is succeeded as division manager, Louisiana division, by **J. H. Rambin, Jr.**, formerly assistant division manager.

Harry X. Bay, division geologist, has advanced to assistant division manager, and **L. W. Calahan**, senior geologist, stepped up to division geologist.

Keyes, who has been division manager since 1946, joined the company in 1928 as petroleum engineer, and has worked in California as well as the Louisiana-Arkansas division.

Rambin, a Louisiana State University graduate, joined The Texas Company in 1935, and has been assistant division manager at New Orleans since 1945.

Bay, who holds M.S. and Ph.D. degrees in geology from the University of Iowa, was employed by The Texas Company as geologist in 1936.

Calahan was graduated from the University of Oklahoma in 1937, and that year joined The Texas Company.

•

Roger D. Stanwood has joined Transcontinental Gas Pipe Line Corporation as assistant to **Ionel I. Gardescu**, vice president of gas supply. Stanwood was with Tide Water Associated Oil Company for more than 11 years, and was most recently assistant superintendent of its Gas Utilization department. He was graduated from Dartmouth College in 1939, and is a member of AIME. He will have offices in Houston.

R. D. Stanwood

•

Graydon A. Scrafford has been appointed vice president and general manager of The Buckeye Pipe Line Company, with offices at Lima, Ohio.

DEATHS

John J. Ohern, 64, an original partner in Skelly Oil Company, died June 19 at Laredo, Texas. Ohern, who had started in the fields at the age of ten, was also founder of the United Gulf Gas Company, which is now United Gas Corporation. He was a director of Mid-Continent Oil and Gas Association from the time the group was organized.

•

Alister Campbell, 37, production superintendent for the Seaboard Oil Company of Delaware, Rocky Mountain region, died June 13 in an airplane crash in the Big Horn Basin in Wyoming. He was formerly an engineer with Stanolind Oil and Gas Company at Tulsa.

•

Robert M. Garrett, 43, Texas independent oil operator, died June 2 in Dallas.

•

Harry H. Gilpatrick, 77, senior director of Wilcox Oil Company, died June 6 in Kansas City.

•

Lt. Col. Mel B. Trelfall, USMC, formerly with Clayton-Mark Company, Frick-Reed Company and The National Supply Company, died May 26 in San Francisco.

•

W. B. (Shorty) Wilson, 65, of Tulsa, formerly chief geologist for the Tulsa division of Gulf Oil Corporation, died May 21 in Hartford, Conn. He joined Gulf in 1916 and was made consulting geologist in 1945, holding that position until his retirement last year.

•

Basil H. Lucas, Jr., 37, secretary-treasurer of Hiawatha Oil & Gas Company, Penn-Ohio Gas Company, and Melben Oil Company, died May 9. He was director of the three companies, as well as of Republic Oil Refining Company, Republic Pipe Line Company, and Duval Pipe Line Company. Lucas has been with Benedum-Trees interests for 13 years.

•

Frank B. Long, 70, retired vice president of Oklahoma Natural Gas Company, which he joined in 1927, died May 8 in Tulsa.

•

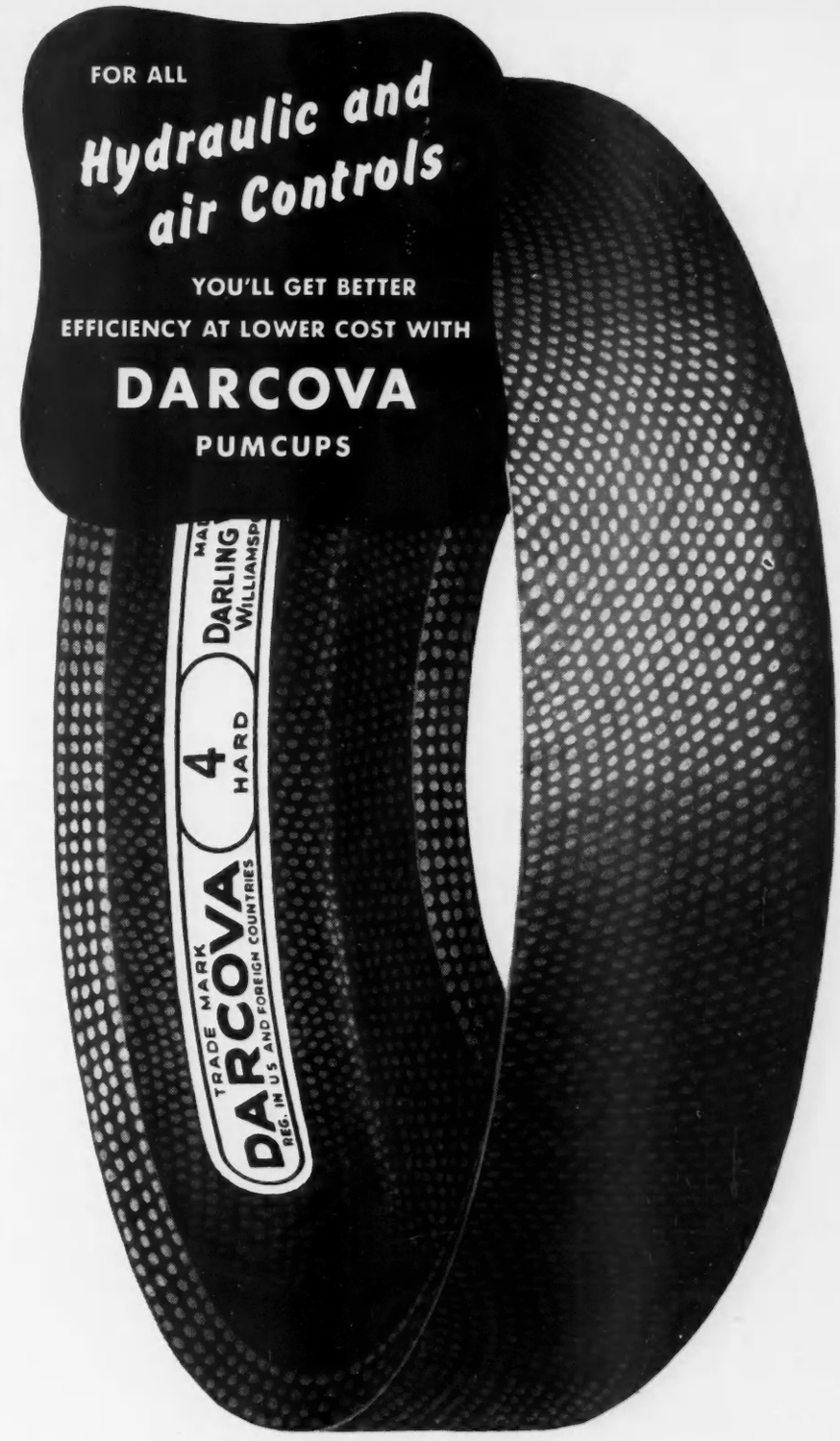
Rubert J. Lindquist, 48, financial vice president of Standard Oil Company of Indiana, died May 5 in Chicago. Lindquist, who supervised and coordinated all financial, accounting and tax affairs for the company, joined Standard as financial vice president in 1945 and was elected a director in 1946.

•

William W. Walters, 72, veteran oil well supplies salesman for Layne & Bowler Company, died May 20 in Houston. He went to work for Layne & Bowler about 1903, and served in South Texas and Louisiana territories until his retirement a few years ago.

•

Thomas R. Jones, 60, founder and former president of Oklahoma Contracting Company, died May 20 in Dallas. He was president of the company for 32 years.



There's a free bulletin full of reasons and proof. Ask for it today!

DARLING VALVE
& MANUFACTURING CO.
Williamsport 7, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

PUMCUPS

B and W
SCRATCHERS
AND
CENTRALIZERS
FOR
A GOOD CEMENT JOB

B and W NU-COIL SCRATCHERS

Both are HINGED for quickest, easiest money-saving installation anywhere!

B and W LATCH-ON CENTRALIZERS

with the NEW
KON-KAVE BOW

Strongest, Safest and Easiest to Install!

B and W Incorporated
* Well Completion Specialists *

WEST COAST — 3545 Cedar Avenue
Long Beach 7, California, Long Beach 4-8366
GULF COAST — P. O. Box 5266
Houston 12, Texas, Phone: WEntworth 6603

Companies in the News

Sunbeam officers are, left to right, Vernon Howell, G. B. Howell, Walter Duncan, Jr., and Robert J. Beams.

SUNBEAM OIL COMPANY, a new firm with offices in the First National Building, Oklahoma City, has been organized to operate in the Mid-Continent area. **G. B. Howell**, president of the firm, is an independent operator with extensive oil production in Oklahoma, Illinois and West Texas. The vice president. **Vernon Howell**, is with Howell and Howell, who operate rotary tools in Oklahoma and have production in Oklahoma and the Texas Panhandle. **Walter Duncan, Jr.**, secretary treasurer, is jointly active with Howell and Howell in the Elk City field area of Beckham County, Okla. **Robert J. Beams**, vice president and chief geologist for Sunbeam, will open an Ardmore office for the company in August. He was formerly with Shell Oil Company, and more recently was a consultant.

•

PLAINS PIPE LINE COMPANY, a firm owned jointly by Phillips Pipe Line Company and Cities Service Oil Company, has been organized, it was announced by **K. S. Adams**, chairman, and **Paul Endacott**, president, of Phillips Petroleum Company, and **A. W. Ambrose**, president of Cities Service.

This new company, owned 50 percent by Phillips and 50 percent by Cities Service, will operate a new crude oil pipe line and gathering system in the Spraberry trend in West Texas. Construction is well underway. The lines will extend through the prospective producing territory of Midland, Glasscock, Reagan, and Upton counties and will be in a position to serve all production from this area.

Officers of the new company are **D. M. McBride**, president; **B. F. Stradley**, vice president and treasurer; **W. H. Wallace**, vice president and manager; **C. S. Mitchell**, vice president; **Paul J. Parker**, secretary and assistant treasurer; **W. F. Martin**, assistant secretary and assistant treasurer; **T. V. Stevens**, assistant trearurer; **Lloyd Lynd**, assistant treasurer; **R. E. Arnold**, assistant secretary; **F. B. Plank**, assistant secretary, and **J. F. Kinslow**, assistant secretary.

•

TENNESSEE PRODUCTION COMPANY is now the name of the company formerly known as Sterling Oil & Gas Company. More than 99 percent of the common stock of the firm, an oil and gas producing company operating in the Gulf Coast area, is owned by Tennessee Gas Transmission Company, and the new name conforms to that of the parent company. **Gardiner Symonds** is chairman of the board of directors of Tennessee Production Company, which has offices in the Commerce Building, Houston.

•

THE TEXAS COMPANY will construct a 16-story office building at the corner of Canal and Marais streets in New Orleans as division headquarters for the Sales and Producing departments. Construction will probably be completed in the fall of 1952.

R. L. Keyes, division manager, Louisiana division, Producing department, and division office personnel, and **M. J. Epley, Jr.**, general attorney, and the Legal department staff will move from the National Bank of Commerce Building to the new Texaco headquarters.

Associations

New Officers of the Tulsa Geological Society are, left to right, E. P. Neal, Tide Water Associated Oil Company, second vice president; E. V. McCollum, E. V. McCollum & Company, and E. Floyd Miller, consulting geologist, councilmen; Mrs. H. V. P. Branson, Shell Oil Company, secretary-treasurer; John C. Maher, U. S. Geological Survey, retiring president; H. T. Morley, Stanolind Oil & Gas Company, councilman; V. L. Frost, The Ohio Oil Company, President; Robert J. Lantz, Woods Drilling Company, business manager for the *Digest*. Not shown are Garvin L. Taylor, Stanolind, first vice president, and Harold E. Enlows, University of Tulsa, editor.

SEG Midwest Meeting To Be In Dallas November 19-20

The Society of Exploration Geophysicists will hold its annual midwest regional meeting November 19 and 20, at the Baker hotel in Dallas, it was announced by Dr. Karl Dyk, of Stanolind Oil and Gas Company, Tulsa, chairman of the program and arrangements committee.

The meeting will be sponsored jointly by the Dallas, Fort Worth, Midland, Shreveport and Tulsa local sections of the SEG, and the Geophysical Society of Tulsa will be responsible for the program and arrangements.

Dr. E. M. McNatt, The Carter Oil Company, is in charge of the two-day technical sessions; Jay P. Garner, president of Oil Exploration, Inc., will arrange the entertainment; and K. M. Lawrence, Amerada Petroleum Corporation, will accept advertising for the printed program. Other members of the Tulsa section serving on the arrangements committee are Dr. W. H. Courtier, Phillips Petroleum Company, Bartlesville, and Frank Searcy, of Continental Oil Company, Ponca City.

Dr. Dyk said that most of the papers presented will concern geophysical problems encountered in the midwestern oil producing region of the U. S., and will include a featured address by an outstanding speaker.

Field Trips and Conferences Planned by Wyoming Geologists

Oil possibilities of south central Wyoming will be investigated August 1-3 when more than 200 geologists meet in Sinclair, Wyo., for the Sixth Annual Field Conference of the Wyoming Geological Association. The program will include transportation of participants in a 65-car caravan to various points of geologic interest in a 4200-square mile area, of which less than 12 square miles now produces oil or gas.

General chairman is R. W. Mallory, Stanolind Oil and Gas Company. W. F. Brinker, Cities Service Oil Company, and Dr. D. L. Blackstone, Jr., are joint editors of the 200-page Guide Book now being prepared, and George Veronda, The Ohio Oil Company, is in charge of caravan arrangements.

Chicago Is Selected as Site Of API 1952 Annual Meeting

The American Petroleum Institute board of directors has approved Chicago as the site of the 1952 annual meeting, which will be held November 10-13. The 1951 annual meeting will be held in Chicago November 5-8.

The board of directors also elected to membership Glenn E. Nielson, Husky Refining Company, Cody, Wyo., and A. A. Stambaugh, The Standard Oil Company (Ohio), Cleveland.

Golden Oil Jubilee Will Be Celebrated in Louisiana

Governor Earl K. Long has proclaimed 1951 to be Louisiana's Golden Oil Jubilee Year, and has invited those associated with the state's oil and gas industry to participate in the celebration, which will be held September 21-23. The ceremonies will be held at Jennings, La., site of Louisiana's first discovery well, which was brought in on September 21, 1901.

CATAWISSA PERFECT SEAL UNIONS

deliver sure-fire piping dependability THROUGHOUT THE OIL FIELDS!

typical Oil Field PRODUCTION TANK installation

In high or low pressure, extremely high temperature or corrosive piping conditions, CATAWISSA HOT FORGED STEEL UNIONS are maintaining their long-standing reputation for sure-fire piping dependability!

CATAWISSA PERFECT SEAL UNIONS are designed and produced for dependable, long-life service under the severest piping conditions—made with hand ground seats that require no packing and feature Catawissa's Ball-To-Angle seat design which gives a PERFECT SEAL even when the pipe is not in alignment!

write or call for your copy of the NEW CATALOG 11 showing the complete Catawissa Line

stocked and distributed by

OIL WELL SUPPLY CO.

Branches Serving All Oil Fields

Catawissa Valve & Fittings Co.—Catawissa, Penna.

Officials Named for NACE's 1952 Conference and Exhibit

Officials for the 1952 Conference and Exhibition of the National Association of Corrosion Engineers are Walter F. Rogers, Gulf Oil Corporation, Houston, general chairman; Robert L. Bullock, Interstate Oil Pipe Line Company, Tulsa, technical program chairman; Jack W. Harris, Cameron Iron Works, Houston, exhibition chairman; and Charles G. Gribble, Jr., Metal Goods Corporation, Houston, local arrangements chairman.

The conference will be held at Galveston, Texas, during the week of March 9. It will be the first time since the 1944 meeting at Houston that the association has held a national meeting in the Southwest. A four-day technical program and exhibition is planned.

Headquarters of the conference will be the Galvez Hotel, and both technical sessions and the exhibits of corrosion mitigation materials will be on the Galveston Municipal Pier.

Geological Group Organized By Nine Gulf Coast Societies

The Association of Gulf Coast Geological Societies has been organized by nine area groups, for the purpose of holding an annual meeting where pertinent papers may be presented, and offering quick publication and efficient distribution of those papers.

November 15-17 has been set as the time for the first meeting, which will be in New Orleans. Houston will be the host city for the 1952 meeting, and San Antonio for the 1953 meeting.

Leslie Bowling, New Orleans, was chosen chairman of the Steering Committee, which is composed of representatives from each of the organizing societies. Robert D. Sprague, of the Mississippi Geological Society, was named vice chairman, and E. L. Earl, Houston, was elected secretary of the committee.

Member geological societies in the AGCGS are New Orleans, Houston, South Louisiana, Shreveport, South Texas, Mississippi, East Texas, Corpus Christi and Southeastern.

ASME Petroleum Division Meet Will Be Held September 24-26

The conference of the American Society of Mechanical Engineers Petroleum Division will be held September 24-26 in Tulsa.

At least five papers will be read before each of the four main sections of the division. Included among the production papers are "Theoretical Analysis of Sucker Rod Loads," by Dr. E. N. Kemler, and "Inherent Mineralogical Factors to be Considered in Drilling Hard Rock," by Dr. W. B. Mather. The Materials Committee has talks scheduled on T steels, new metals, and electrodes for special applications. The Manufacturers Committee has papers on power pump development, magnetometers, and high capacity boilers. Pipe line control equipment and other aspects of pipe line operation and design will be discussed by the Transportation Committee.

An attendance of more than 300 is expected.

NOT A GHOST OF A CHANCE!
Paraffin congestion in pumping wells? NOT A CHANCE—with S-I-W M-25 paraffin scrapers! As a result of research and field experience the Sunshine Iron Works has engineered a new and better paraffin scraper for pumping wells. Our M-25 Features: (1) EFFICIENCY — two heavy blades spiralled and welded around shell halves exert a continuous unplugging effect in the hole as they curl off the paraffin with every stroke, (2) STRENGTH -- the M-25 gets a real grip on the rod, (up to 5,000 lbs. by test) and stays put, (3) WEARABILITY — heavier construction assures long dependable operating performance, (4) EASY FIELD INSTALLATION — M-25's are easily and quickly installed on the spot. Order a supply today.
• NEW DESIGN
• GRIP OF STEEL
• LONGER WEARING
Write for complete catalog of Sunshine Iron Works Paraffin control equipment.
Sunshine Iron Works
PHONE 4374
601 W. MURPHY
ODESSA, TEXAS

Incoming Chairman of the Southwestern Gas Measurement Short Course, James L. Griffin, left, accepts the gavel from Ben F. Worley, who acted as 1951 chairman. Griffin is with Northern Natural Gas Company, Omaha, and Worley is an employe of United Gas Corporation, Shreveport.

Houston Geophysical Society Elects Johnson President

Earle W. Johnson, president of General Geophysical Company, has been elected president of the Houston Chapter of the Society of Exploration Geophysicists.

Earle W. Johnson

Johnson succeeds Roy Bennett, Sohio Petroleum Company, as president of the group.

E. E. Rosaire has been presented a lifetime membership in the society for his pioneer work in geophysics.

Paul Andrews Will Head API's Pacific Coast Production Group

The Pacific Coast district of the API Division of Production has elected Paul Andrews, Signal Oil & Gas Comapny, Los Angeles, as chairman. Andrews, chief production engineer for Signal, succeeds E. C. Babson, Union Oil Company of California, Los Angeles. During the past year, Andrews served as general chairman under Babson.

Paul Andrews

Vice chairman of the district are C. C. Gandaubert, General Petroleum Corporation, Los Angeles, Los Angeles Basin area; W. T. Woodward, Woodward and Reynolds, Taft, South San Joaquin Valley area; B. B. Grainger, Tide Water Associated Oil Company, Ventura, coastal area; and J. C. Chescheir, Jr., Tretolite Company, Coalinga, Coalinga-Kettleman area.

Re-elected were C. T. Reichert, of The National Supply Company, Torrance, as treasurer; and Mrs. Elsie Edmiston, API, Los Angeles, as secretary.

M. W. Morris, Standard Oil Company of California, La Habra, was named chairman of the Advisory Committee.

Tulsa Geophysical Group Names Gemmer President for New Term

The Tulsa section of the Society of Exploration Geophysicists has chosen R. W. Gemmer, chief peophysicist for The Carter Oil Company, president. Others new officers are Craig Ferris, partner in E. V. McCollum & Company, first vice president; Dr. J. E. Hawkins, research director of Seismograph Service Corporation, second vice president; J. C. Rollins, interpreter for Frost Geophysical Corporation, secretary; and Clare N. Hurry, geophysical operations assistant for Carter, treasurer.

Meeting Dates Are Changed

The time for the annual meeting of the Louisiana-Arkansas Division of the Mid-Continent Oil & Gas Association has been changed to November 1 and 2, to avoid conflict with the API meeting in Chicago. Headquarters will be in the Roosevelt Hotel, New Orleans.

It's a cinch to ream pipe with this RIDGID

Extra-long-taper reamer won't thin, flare or split pipe

● RIDGID LonGrip reamers have that extra-long-taper that cleans the burr smoothly out of pipe or conduit almost without effort. Just a few light ratcheted strokes do the job. Furnished complete with ratchet handle. No. 2 Reamer unit sold separately for use in RIDGID 00R small ratchet die handle. Two sizes, No. 2, ⅛" to 2" pipe; No. 3, ⅜" to 3" pipe. These RIDGID new type pipe reamers really do save your time, work—and pipe. Ask for them at your Supply House.

Buy reamer complete or reamer unit separately for use with 00R die handle.

RIDGID

★ Work-Saver Pipe Tools ★

THE RIDGE TOOL CO. • ELYRIA, OHIO

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Cameron Iron Works honored 450 employes having five years or more service with a banquet in one of the new shop buildings under construction at the Cameron plant on the Katy road in Houston.

Baroid Division Promotes Roberts To General Sales-Service Manager

Amos A. Roberts has been appointed general sales and service manager of Baroid Sales Division, National Lead Company. Roberts, formerly manager of the Mid-Continent division, with headquarters in Tulsa, now has offices in Houston.

Roberts joined Baroid in May, 1935, as field service engineer in the Mid-Continent division. In September, 1943, he became district manager, and shortly thereafter was promoted to manager of the division. A graduate of Oklahoma A. & M. College, Roberts was employed by Skelly Oil Company, Thomas Dietle, and Barnsdall Refining Company before he joined Baroid.

Engineers and Managers Convene in Tulsa for National Tank Meeting

Representing the 39 field branches of National Tank Company at the annual meeting in Tulsa were 39 key men, engineers and managers. Together, their branch offices cover 14 oil producing states in the U. S. and Alberta, Canada. Branch personnel met with approximately 40 Tulsa employes who represented management, engineering, sales, manufacturing and distribution departments.

Highlighting the meeting was a discussion of National's first 25 years of operations, and a presentation of service pins. Receiving 25-year pins were F. W. Baker, Merle Bryan, Jay P. Walker, Cecil G. Wells and Joe Marshall. Spider Allen, Charles Purser, Lloyd Taylor and Joe Wells were awarded 15-year pins. Ten- year pins went to Charles Lavery, Kenneth Shank, Wayne Snow and Noel Webster.

Sales Engineer is Promoted

General American Transportation Corporation has promoted Ben King Duffy, sales engineer, to district sales manager of the Plate & Welding division, for the Pittsburgh district, which includes the western half of Pennsylvania, eastern half of Kentucky, and Ohio, West Virginia and Tennessee.

B and W Appoints Distributors in Canada, Wyoming and Venezuela

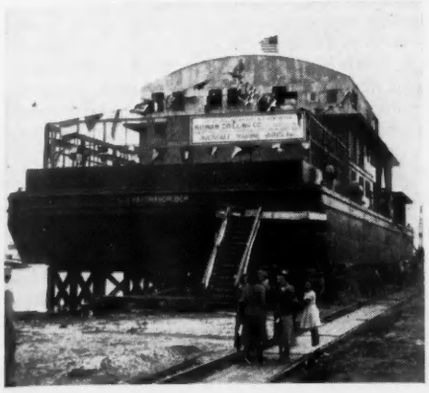
Kenneth A. Wright of B and W, Inc. has returned from Canada. Import Tool Company, Ltd., Calgary, Alberta, owned and operated by Delbert D. Lewis and his son Delbert D. Lewis, Jr., have been selected as Canadian distributors for B and W Scratchers and Centralizers and will maintain stocks at Calgary and Edmonton and will provide field delivery and installation service.

James E. Enrick Company of Casper, Wyo., has been appointed Rocky Mountain distributors for B and W Scratchers and Centralizers. Stocks of this equipment will be warehoused at Casper and at supply stores in active drilling areas. Field installation service will also be available.

Field warehouse stocks of B and W Scratchers and Centralizers have been established at the Vacuum Truck Service Company, C. A., El Tigre, Venezuela, a company owned by Jack Bryan.

At National Tank Company's meeting in Tulsa were the men pictured above. Kneeling, left to right, are Ed deYoung, Herb Walker, Bill Little, Charlie Purser, Bill Todd, Lynn Burrus, Reed Speir and Red Brinkley. Second row: Lloyd Conley, Neely Lowrie, George Steinhaus, Les Lamb, Dick Brooks, Sam Mays, George Powers, Johnny Shelton, Dud Lowrie, Ward Guin, Jack Godwin, Rex Williams, Tracy Smith, Jack Williams, Jim Tallant, Martin Smith, Sherman Barclay. Third row: Earl Keck, L. M. Jewett, Harold Jones, Bill Willis,, Joe Wells, Merle Bryan, S. S. (Pete) Parker, Cliff Hill, Marvin Willis, Floyd Senter, Joe Marshall, Chester Immel, Jim Brown and Ed Fontaine.

EQUIPMENT AND SERVICE SUPPLIERS' NOTES



Submersible Drilling Barge "L. J. Hartmangruber," launched at Avondale Marine Ways, Inc., for Rowan Drilling Company, Inc., Fort Worth, is one of the largest such rigs ever built and is a self-contained unit. It is capable of carrying a full complement and supply of pipe and other equipment, including full capacity of fuel and fresh water. The barge is diesel-electric powered by five Cooper-Bessemer engines operated through a central control panel. Derrick floor elevation of 20 feet gives a 14-foot clearance under rotary beam. Emsco hoist is installed, and also one E700 and two C350 Ideal pumps. Bulk mud storage is also provided in the 200-foot barge.

Wold Assumes Kobe Managership as Coberly Takes Over Research Plans

L. T. Wold has been elected vice president of Dresser Equipment Company and has been named general manager of the company's Kobe Inc. Division. In this realignment of executive responsibility, C.

L. T. Wold

C. J. Coberly

J. Coberly, founder of Kobe Inc., and inventor of the Kobe hydraulic pump, has been relieved of many general administrative duties. He retains his position as vice president of Dresser Equipment Company, but will devote most of his time to organizing and directing a new Product Research and Development department.

Wold joined Kobe as controller in 1946 and for the past year has been assistant general manager.

Cummins Expands Productive Capacity By Addition of $6 Million Facilities

A major expansion, involving new facilities to cost $6 million, will increase Cummins Engine Company, Inc., production capacity at least 50 percent over the record 1950 high level, a company announcement stated. The new program matches the more than $6 million already expended by Cummins in the five-year period following World War II, during which productive capacity was increased about 60 percent.

You've Got to

PLAY IT SAFE

When it's Fire or Steam!

In the oil industry, two of the hoses you can't afford to take any chances on are fire hose and steam hose. They've got to be designed for the job, *with an extra margin of safety built in.* No hose that leaves our plant gets more care in construction and inspection than the two below. You can depend on them for long, trouble-free *safe* service.

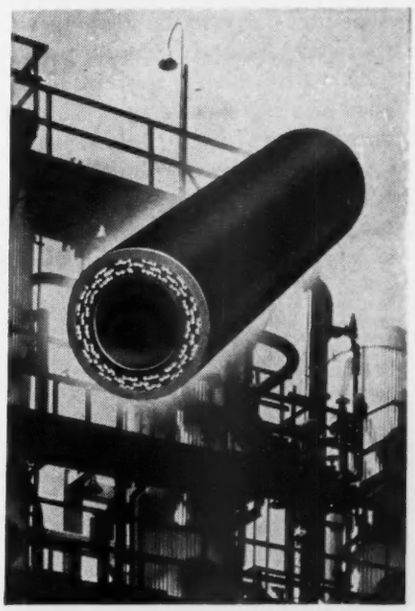
Maltese Cross® Fire Hose . . . . .

The "standard of comparison" with oil refineries for over 80 years . . . unexcelled for foam, chemical or booster use.

The tough cover protects Maltese Cross from oil film, acid fumes and chemicals . . . stops water absorption into the carcass . . . prevents mildew and eliminates need for drying-out after use. Inside is a mildew-inhibited, closely woven duck carcass that provides unusual durability and burst-resistance. Yet Maltese Cross is light, flexible, easy to coil, folds closely.

Fifteen years of active fire-fighting service, plus many more as a utility or clean-up hose, are what you can expect —*and get*—when you play it safe with Maltese Cross.

Monarch® Fiberglas* Steam Hose



Monarch is built to carry saturated steam at temperatures up to 388° F. and pressures up to 200 lbs. . . . and do it day in and day out without failure. The tube is an exclusive Hewitt-Robins development—a special heat-resisting compound that stays soft and flexible without flaking or cracking.

The carcass is multiple-braided Fiberglas cord—unsurpassed for heat resistance and strength—and heavily insulated with heat-resistant rubber. The cover is extra-tough, extra-thick, won't strip or blister . . . highly resistant to heat, abrasion and weather.

For general steam services in the oil industry—insist on Monarch Fiberglas Steam Hose!

* * *

For these and many other specialized oil industry hoses, call your Hewitt Rubber Distributor (listed under "Rubber Products" in the classified 'phone book), or write Hewitt Rubber Division, 240 Kensington Avenue, Buffalo 5, New York.

HEWITT-ROBINS

OIL INDUSTRY HOSE

*T.M. of Owens-Corning Fiberglas Corp.

HEWITT-ROBINS HR **INCORPORATED**

AIR HOSE • BARGE LOADING HOSE • FIRE HOSE • FLOATING ROOF TANK DRAINAGE HOSE
FLUE CLEANING HOSE • FUEL OIL & GASOLINE HOSE • OIL SUCTION & DISCHARGE HOSE
STEAM HOSE • TRUCK TRANSPORT & TANK CAR DISCHARGE-SUCTION HOSE • TANK TRUCK HOSE
TWIN-WELD® WELDING HOSE • PROPANE-BUTANE HOSE FOR HANDLING LIQUEFIED PETROLEUM GASES
WATER HOSE • CONVEYOR BELTING • PIPE SLINGS • RUBBERLOKT® WIRE WHEEL BRUSHES

Reed Roller Bit Company is now operating this new warehouse at 404 Galveston Street in Wichita Falls, Texas, under the supervision of J. R. Brandon, division manager. R. G. Hamaker, Reed vice president in charge of sales, Houston, headed a group from the Houston office which attended a barbecue announcing the opening of the new Reed station.

Pitt Chem Protective Coatings guard your equipment with a tough, surface-protecting film . . . an impervious sheath against strong chemicals, high temperatures, atmospheric exposure and other destructive elements of industrial corrosion and contamination. *Pitt Chem* Coatings are completely uniform and dependable because they are laboratory-controlled from raw materials to finished product. You'll find the cost of safeguarding your equipment with *Pitt Chem* is surprisingly low. ● For more information, write for new booklet, "Control Corrosion Through Pitt Chem Protective Coatings."

★ Hot Applied Tar Base Coatings ★ Cold Applied Tar Base Coatings ★ Alkyd Base Coatings
★ Chlorinated Rubber Base Coatings ★ Vinyl Base Coatings ★ Phenolic Base Coatings

Protective Coatings Division

PITTSBURGH
COKE & CHEMICAL CO.

WAD 3726

GRANT BUILDING,
PITTSBURGH 19, PA.

OFFICES: NEW YORK • CHICAGO • ST. LOUIS • TULSA • HOUSTON • LOS ANGELES • SAN FRANCISCO

National Supply Company Creates Two Divisions; Opens Three New Stores

To serve expanding oil and gas requirements in the Southwest, The National Supply Company has created two sales divisions with headquarters in Houston and Fort Worth. The Southwest division, with headquarters at 3109 Winthrop Street, Fort Worth, consists of the 20 stores operated in North Louisiana, southern Arkansas, East, North and West Texas, New Mexico and the Panhandle. James M. Thompson is division manager.

The Gulf Coast division, with headquarters in the Commerce Building, Houston, will be under the management of John W. Babb and will be comprised of

J. M. Thompson

John W. Babb

15 stores in Mississippi, South Louisiana and the entire Gulf Coast region.

New facilities have been installed at Shreveport to replace the company's store which had operated there since 1910. The new store will serve the North Louisiana, East Texas and South Arkansas areas. R. E. Brock is store manager.

National Supply has opened a new store at San Angelo, Texas, to serve 13 Texas counties: Coleman, Coke, Tom Green, Irion, Runnels, Schleicher, Sutton, Kimble, Menard, Concho, McCulloch, Mason and Sterling. J. Marcus Powell, who has been with the company 27 years and representative at San Angelo the past two years, is store manager.

A third new store was opened at Shidler, Okla., Osage County, to serve the Burbank field. Glenn L. Gordon, former salesman at Hominy, Okla., is in charge of the Shidler store.

Appointments included those of A. F. White, Jr., as assistant district manager of the Midland, Texas, district, and C. P. Triplitt as store manager at Odessa, Texas.

John Seagren was named chief engineer of National Supply's Engine division at Springfield, Ohio, and Harvey W. Hanners and George F. Noltein were named chief research engineer and consulting engineer, respectively.

Frank L. Johnson was named manager of export sales of the Engine division, and will make his headquarters at 600 Fifth Avenue, New York 20. Also moving to the same New York address is the office of Spang-Chalfant division. National Supply Export Corporation and the two offices of the National Supply divisions will occupy the 20th and 21st floors of a new building.

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Rector Well Equipment Appoints Tri-State Area Division Manager

E. W. Brockman has been appointed division manager for Oklahoma, Kansas and the Texas Panhandle for Rector Well Equipment Company, and will have offices in Tulsa.

E. W. Brockman

A geological engineering graduate of the University of Oklahoma, Brockman spent three years doing survey work in South Louisiana for Petty Geophysical Engineering Company. He joined Rector in 1936 as sales representative in Oklahoma. After serving in the Army from 1942 to 1945, he rejoined Rector as sales representative in Oklahoma and Kansas. Later in 1945 he entered business as a manufacturer's agent, a business he conducted until his recent appointment.

Schlumberger Transfers A. P. Claudet To Executive Post in South America

A. P. Claudet, formerly manager of the Southeast area, New Orleans, for Schlumberger Well Surveying Corporation, has been appointed vice president and general manager of Schlumberger Well Surveying Corporation, Surenco, S. A., and of the Schlumberger office of Latin America, S. A. He is stationed in Caracas, Venezuela.

Claudet has been in New Orleans since 1941, and had previously worked for Schlumberger elsewhere in the U. S. and abroad.

C. A. Doh, formerly area manager of the Northeast area in Mattoon, Ill., has been appointed to replace Claudet at New Orleans. Doh has been area manager at Mattoon since 1945, and had previously been assigned to East Texas, Venezuela, Trinidad and Rumania.

John Brennan Tours South America For Fluid Packed Pump Company

John Brennan, Fluid Packed Pump Company sales engineer, is on an extensive business trip to South America. He will tour the Western Venezuelan fields and review operations at the Los Marchus pump service shop. From there he will go to Eastern Venezuela to assist National Supply Company of Venezuela personnel in opening a new down-well pump shop for servicing Oilmaster products. The last leg of his journey will take him to Peru where he will study down-well pumping needs.

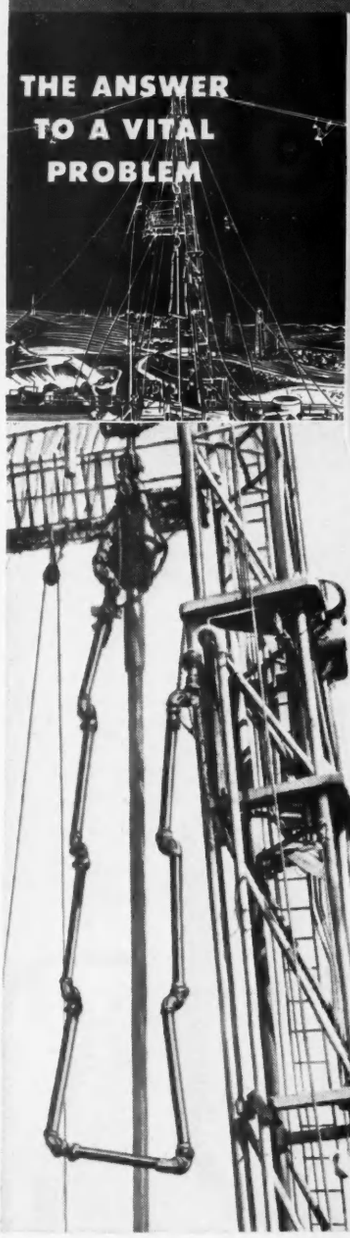
John Brennan

Promoted to Store Manager

E. D. Lawrence, field salesman at Lake Charles, La., for Continental Supply Company, has been made store manager there.

CHIKSAN

ALL-STEEL ROTARY HOSE



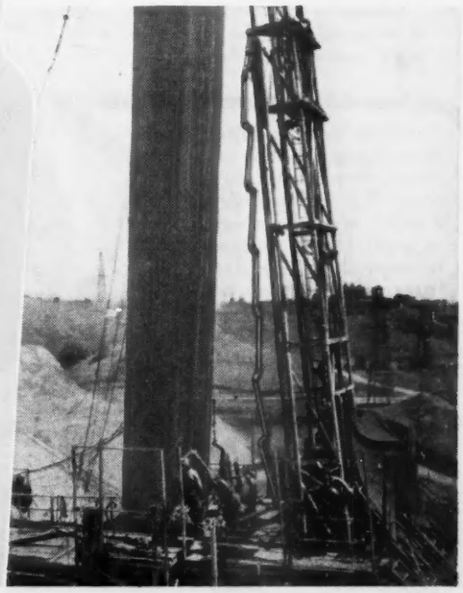
CHIKSAN has engineered the answer to the problem of Rotary Hose on Jack-Knife Rigs...and proved it in the field.

The combination of constant flexing and bending on short radius and frequent change of rig location with the probability of damage in transit makes ordinary hose a short-lived investment.

CHIKSAN *All-Steel* Rotary Hose eliminates the cost of replacement and down-time...as well as hazardous conditions.

With **CHIKSAN *All-Steel* Rotary Hose,** you save on hose cost per foot of well drilled and, at the same time...you get uniform strength and safety all the way...from slush pump to well bottom. You save down-time, too, because you eliminate the time required to replace ordinary hose...and you also save hazards and possible damage to the well and your equipment.

Play safe! Use **CHIKSAN *All-Steel* Rotary Hose** *all the time, every time.*



Send us the make and model of the Jack-Knife Rig you operate...we'll gladly submit recommendations.

CHIKSAN TRADE MARK REG.

CHIKSAN COMPANY

AND SUBSIDIARY COMPANIES

Chicago 3, Ill. **BREA, CALIFORNIA** Newark 2, N. J.

WELL EQUIPMENT MFG. CORP. HOUSTON 1, TEXAS

CHIKSAN EXPORT CO. BREA, CALIFORNIA NEWARK 2, N. J.

The new offices and manufacturing plant of Wagner-Morehouse, Inc., in Los Angeles.

←

California Firm Observes 15th Year; Moves to New Manufacturing Plant

Wagner-Morehouse, Inc., celebrated its 15th anniversary as a producer of "Streamline" oil well drilling and servicing equipment by occupying its own new manufacturing plant at 5909 Randolph Street in Los Angeles. Charles D. Wagner, president, and Harry C. Morehouse, vice president, have each spent most of their business careers in oil field engineering and manufacturing activities.

The new plant, which occupies two acres in east Los Angeles, consolidates two operations previously separated—a derrick and fabricating plant and a machine and assembly shop. An area of approximately 50,000 square feet is provided for fabrication of derricks, portable rigs, and structural work. Machine and assembly department incorporates steel construction and equipment, and consists of about 10,000 square feet of floor space. A two-story building fronting the property houses general offices and engineering departments.

Gates is Advanced to Sales Manager Of Well Equipment Manufacturing

John W. Gates, formerly assistant sales manager, has been appointed sales manager of Well Equipment Manufacturing Corporation, Houston, succeeding Tracy T. Word, Jr., resigned.

John W. Gates

Gates' recent appointment follows a series of promotions since he joined Weco in 1946 after four years in the Navy. After working in the Manufacturing department, he was transferred to the Sales department as Gulf Coast representative and later promoted to manager of the Southern division, a position he held until his appointment as assistant sales manager early in 1950.

Diamond Drilling Company Expands Operations to Ventura Oil Fields

Art Moore and Ralph Ruse of Diamond Drilling Company, Long Beach, Calif., have opened a new branch in Ventura, Calif., at 1665 North Ventura Avenue. The new office will be under the management of Jack Flanakin, who has been operating with Diamond Drilling in the Los Angeles Basin area since the company's inception. A complete line of coring tools will be stocked at Ventura, including Soll conventional and wireline telescoping core barrels, diamond coring bits (both wire lines and conventional, with or without telescoping core barrels), and diamond bits for making hole.

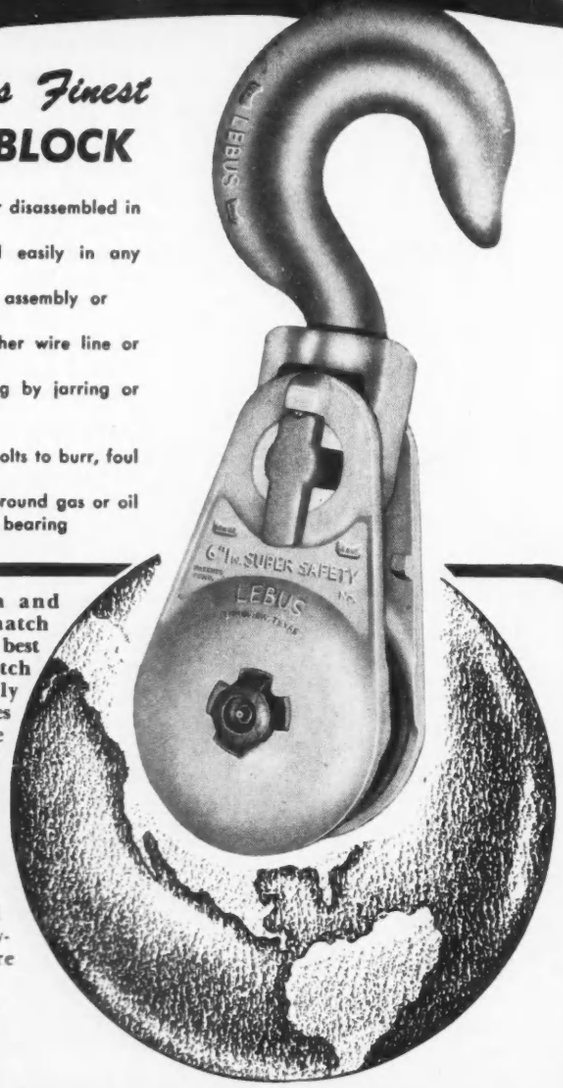
Moves Pittsburgh Offices

Oil Well Supply Company's tubular office and its Eastern division sales office, both in Pittsburgh, have been moved into U. S. Steel Corporation's new office building at 525 William Penn Place in that city.

LeBus ALL PURPOSE SNATCH BLOCK

The World's Finest
SNATCH BLOCK

- EASILY ASSEMBLED or disassembled in difficult places
- Line can be inserted easily in any difficult position
- No tools needed for assembly or disassembly
- Can be used with either wire line or manila rope
- No Accidental opening by jarring or vibration
- No losing of parts
- No threaded nuts or bolts to burr, foul or lose.
- No sparking danger around gas or oil
- Oil and dust seal for bearing



For Safety, Strength and Durability, LeBus Snatch Blocks meet the World's best tests. The LeBus Snatch Blocks may be readily adapted for all purposes through their complete interchangeability of parts. They are completely drop forged of alloy and high carbon steel and are thoroughly heat treated for strength and durability. LeBus Snatch Blocks are given the full strength test before leaving the plant and are fully guaranteed.

WRITE FOR BULLETIN

LEBUS

BUY FROM YOUR SUPPLY STORE

LEBUS ROTARY TOOL WORKS

P.O. BOX 2352 LONGVIEW, TEXAS L.D. Phone 5

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Mudco Adds Key Sales Personnel; Assigns Agents in Three States

R. R. Matthews

W. W. Carson

R. R. (Lefty) Matthews has joined Mudco, Inc., Tulsa, and will be connected with the sale of Mudco O-Ring Butterfly Valves, directing and coordinating sales of Mud Products equipment representatives in all districts.

W. W. (Kit) Carson, field representative for Mud Products, Inc., at Woodward, Okla., has been transferred to Tulsa and will work on the sale of Baroid products.

Appointed as joint agents for the sale of Mudco O-Ring Butterfly Valves in West Texas and New Mexico are R. Q. (Dick) Swindler and Harry W. Denton, whose headquarters and warehouse are at Odessa, Texas.

Matthews began his oil field equipment career in 1931, and has worked in Texas, Louisiana and Kansas. He was previously Kansas district manager for International Derrick & Equipment Company.

St. Clair and Ferguson Assigned To West Coast and Texas Positions

W-K-M Company has appointed J. E. St. Clair of Los Angeles as agent in California, Washington and Oregon. St. Clair was long associated with the late Gene

J. E. St. Clair

Theo Ferguson

McIntyre, former W-K-M agent in the area.

Theo Ferguson has been appointed district manager for West Texas, and will have under his supervision Clyde Cook, who is moving his headquarters from Hobbs, N. M., to Odessa, Texas. Ferguson's offices are in Midland, Texas.

Fluid Packed Pump Appoints Two

V. A. Kelly, formerly district salesman at Snyder, Texas, for Fluid Packed Pump Company, has been promoted to division engineer for North and West Texas. Herb Risner, formerly with American Iron & Machine Works Company, has joined Fluid Packed Pump Company's sales force with headquarters at Los Nietos.

Announcing . . .

World Oil's Special International Operations Issue . . . July 15, 1951

The most complete and up-to-date source of information on global oil operations—covering *every* country with oil development outside the U. S.

This special International Operations Issue of WORLD OIL will bring you the *finest* and *largest* collection of oil field maps bound under one cover. There are over seventy maps in this issue, showing —in *color*—the size, shape and location of oil and gas fields, pipe line outlets and the location of each refinery.

You will receive complete drilling and production information from every oil producing country in the world. This data is presented by *individual fields* and includes such vital information as: current production levels, cumulative recovery, number of producing wells, producing depths, producing formations, number of wells completed and total footage drilled.

Don't miss this important special issue. If you are not now a regular subscriber to WORLD OIL, start a personal subscription now by filling in the coupon below. The cost is small—just $2 a year. Your subscription will entitle you to 14 issues including this special International Operations Issue. Mail the coupon today.

Start a personal subscription to WORLD OIL today

WORLD OIL
P. O. Box 2608, Houston 1, Texas

☐ New Order
☐ Renewal

Enter my subscription to WORLD OIL for the following period:
☐ 1 Year—$2. ☐ 2 Years—$3. ☐ 3 Years—$4.

Name _____ Position _____

Company _____

Street & No. _____

City _____ Zone _____ State _____

We're engaged in:
☐ Exploration ☐ Production ☐ Service ☐ Manufacturing
☐ Drilling ☐ Pipe Line ☐ Supply ☐ _____

☐ Remittance enclosed ☐ Bill me later G-1

Double Seal Ring Names Manager Of Eastern Manufacturing-Sales

M. A. Moore has been promoted to Eastern division manufacturing and sales manager of the Double Seal Ring Company, Fort Worth. Moore, who was formerly Double Seal's sales and service representative in Maine, Vermont and New Hampshire, will have his headquarters at the company's Eastern division factory and sales office at New Rochelle, N. Y.

WORLD OIL'S Trading Post

CLASSIFIED ADS — SERVICES PERSONNEL USED EQUIPMENT

RATES: Regular Classified (undisplayed) set in this size type: 10 cents per word. If Box Number is to be used count an additional six words. Replies forwarded without charge. Situation Wanted: 5 cents per word. Display advertisements, set in suitably larger type with ruled border: $9.00 per column inch per insertion. Situation Wanted: $4.50 per column inch. **All classified ads payable in advance.** 10% Discount if 3 or more insertions are ordered at one time. **COPY DEADLINE:** 5th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

We have the following electric motors in stock for immediate delivery

Size	Phase	Speed	Class
1 HP	1 or 3	1750	Explosion or Splash proof
1½ HP	3	1140	Splash proof
2 HP	3	1750	Splash proof
3 HP	1 or 3	1750	Explosion or Splash proof
5 HP	1 or 3	1750	Explosion or Splash proof

Lubbock Machine Co., Inc. Box 1138, Lubbock, Texas. Telephone 4631.

FOR SALE

For Sale—Shallow drilling block with subsurface geology, in North Texas. C. G. Hart, 1603 Hiram, Fort Worth 3, Texas.

■ FOR SALE—River Ranch on Pedernales. Scenic beauty, ¼ mile of river front. Lots of good water. All fences overhauled and goat-proof. Deer, quail, turkey, fishing and swimming. Many good grasses. 60 acres good farm. Good tanks and well, nice houses and barn. Well improved and good for Dude or Cattle Ranch—1100 acres or more. 40 miles west of Austin, 75 miles north of San Antonio. Sale price $110.00 per acre. Write owner 523 Alexander Hamilton Drive or call Parkview 2-4496 San Antonio, Texas.

■ Well drills, spudders, rotaries, core-drills. All sizes new and used equipment. Tools, drill pipe, cable, pipe. Fishing tools rented. Everything for well drilling. Pressey & Son, Pueblo, Colorado.

■ FOR SALE: Used Askania Magnetometers. % Magnetometer Repair Department. Robertson Instrument Company, 5022 Ennis Street, Houston, Texas, JA-5813.

WANTED TO BUY

■ WE WILL BUY Producing Oil Royalties. Send Particulars. Standard Security Co., 115 Broadway, New York 6, New York.

SITUATION WANTED

Drilling contractor operating in West Texas and New Mexico desires to contact small or medium-sized independen oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box 94-W, WORLD OIL, Houston 1, Texas.

HELP WANTED

HELP WANTED

WANTED

OIL FIELD ENGINE SALES MANAGER

for Large Well-Known Manufacturer of Diesel and Gas Oil Field Engines. Must be able to handle sales and salesmen for Continental U. S. Willing to travel. Age—45 years. Give experience, qualifications and salary expected. Write Box 20-W, c/o WORLD OIL, Houston, Texas.

■ GEOPHYSICIST. Aggressive small independent oil company, concentrating exploration in the Mid-Continent, Gulf Coast, and Rocky Mountain Areas, with established Geophysical Department, has opening for Chief Geophysicist with at least five years seismic experience as Party Chief or Supervisor to take charge of and actively supervise company-owned and operated field crews. Major oil company experience preferred. Headquarters will be in company's main office. Write giving full details as to schooling and experience. Replies held strictly confidential. Box 19-W, c/o WORLD OIL, Houston, Texas.

Wanted—PRODUCTION MAN capable of making drilling contracts, buying materials, completing wells, etc.—must be good. Write Box 21-W, c/o World Oil, Houston, Texas.

DECALS

TRUCK LETTERING AND TRADEMARK decals made for your trucks. Easy to apply, uniform, distinctive, economical for small or large needs. Write for Catalog. Mathews Company, 827 S. Harvey, Oak Park, Ill.

Read the Trading Post For Sales, Services

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Top Management is Reorganized by Buda Engine Sales & Service Firm

Following a management reorganization of Buda Engine Sales and Service, Inc., Tulsa, O. F. Dickenson was named president and treasurer; T. J. Plummer, vice president in charge of store operations and service; Thomas J. Howard, general sales manager; Miss L. G. Burkett, secretary, and L. R. Whitfield, assistant treasurer and assistant secretary.

O. F. Dickenson

Dickenson joined the company in 1938 as secretary-treasurer and was made a vice president several years later. Plummer is a veteran employe of the company, having started in the Tulsa parts department in 1935, and has worked in all territories served by the organization. Howard was first employed as sales engineer and shortly afterwards was placed in charge of priorities and war contracts during World War II. Miss Burkett has been with Buda since 1943 and has served as secretary since 1946. Whitfield joined Buda in the accounting department in 1940 and has recently held the position of company office manager.

T. J. Howard

T. J. Plummer

Dowell Incorporated Establishes Stations, Names Operating Personnel

A new operating station has been opened in Abilene, Texas, and a previously established station has been reopened in Hattiesburg, Miss., by Dowell Incorporated. The Abilene station, which will serve North Texas with acidizing, electric pilot and perforating services, is under the management of W. R. (Bud) Coleman, former service supervisor at Wichita Falls, Texas. John Halfhill, former Wichita Falls service engineer, also transferred to Abilene.

Brantley G. Myers is in charge of the Hattiesburg station, which will offer acidizing and industrial services in Mississippi, Alabama and parts of Louisiana.

Herb Walther, Jr., development engineer for Dowell in Tulsa, has been placed in charge of the sales of cathodic protection products for retarding electrolytic corrosion of pipe lines and industrial equipment. He was formerly with the Industrial division in Richmond, Va. William E. Bunting, a member of Dowell's staff since 1944, has been named development engineer in Chicago, and Richard W. Stetson is the new cathodic protection representative in New York City.

New Books, Maps and Movies

Reef Bibliography

More than 1000 articles are cross-referenced in "Bibliography of Organic Reefs, Bioherms and Biostromes," a new 140-page book. The compilation was made under the supervision of Dr. A. N. Murray, professor and head of the Department of Geology at the University of Tulsa. Final editing was done by W. E. Pugh, senior research engineer on exploration methods for Seismograph Service Corporation. Reef papers are classified by geographic location, geologic age, and general content. The book was published as a service to the oil industry by SSC.

Seismograph Service Corporation, Kennedy Building, Tulsa.

Practical Oil Geology

Recent advances and developments in petroleum geology and engineering are included in the sixth edition of Dorsey Hager's "Practical Oil Geology." The role played by geology and geophysics in exploration and development of natural gas and oil properties is fully covered, as are well logging methods, classification of folding, and deep basin areas of the U. S. favorable for oil and gas.

Considerable basic material retained from earlier editions has been condensed and revised in the new volume.

McGraw-Hill Book Company, 327 West 41st Street, New York 18. $7.50.

Oil and Gas in Ohio

The first of a new series of petroleum and natural gas bulletins covers, in Part 1, Ohio oil and gas drilling statistics for 1950, and in Part 2, oil and gas production, history, regulation, secondary recovery and bibliography. Maps show the active drilling areas and pipe lines, and a chart depicts the geologic location of producing sands. The book was edited by Robert L. Alkire, of the Ohio Division of Geological Survey.

State of Ohio, Department of Natural Resources, Division of Geological Survey, Columbus, Ohio.

Oil Occurrence Research

The fourth volume of "Fundamental Research on Occurrence and Recovery of Petroleum" is a compilation of data resulting from a series of eight investigations, API Research Projects 27, 37, 43, 47 and 49.

J. A. McNally, American Petroleum Institute, 50 West 50th Street, New York 20. $6.

Management Problems

A series of papers by California business men and educators discuss governmental and economic problems now facing management, and how these problems may be met by free and energetic private enterprise. Topics covered by the papers include "Government Regulations of Collective Bargaining," "Economic Problems Ahead for Management," "Western Management Looks Ahead," "The ECA Productivity Program in Europe," and "State of California's New Look in Social Welfare."

The California Personnel Management Association, Fifth Floor, Farm Credit Building, 2180 Milvia Street, Berkeley 4, Calif. $1 each.

Stripper Well Survey

The National Stripper Well Survey gives statistical data on a joint project of the stripper well committees of the IPAA, the National Stripper Well Association, and the Interstate Oil Compact Commission.

Interstate Oil Compact Commission, Box 3127, Oklahoma City 5. Free.

Production and Conservation

A presentation intended mainly for laymen, "Oil and Gas Production" has been compiled by the Engineering Committee of the Interstate Oil Compact Commission to serve as an introductory guide to production techniques and conservation methods. The nature of oil and gas reservoirs and recovery practices are explained in nontechnical language.

University of Oklahoma Press, Norman, Okla. $2.75.

RED DEVIL

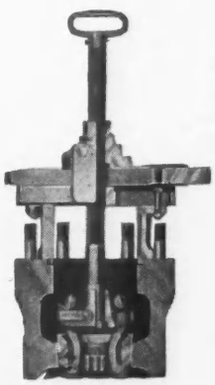
SLUSH PUMP VALVES

For high pressure abrasive service

In the manufacture of Red Devil Valves, particular emphasis has been given to HIGH PRESSURE ABRASIVE SERVICE at lowest possible operating costs. Their design is unique in simplicity, having only 5 parts. Valve and Seat are drop forged for maximum strength and processed for a deep high-carbon case to withstand excessive abrasive action. Seat has the least possible flow restriction and flat surface on bottom provides easy removal with Valve Seat Puller. "DIA-TEX" Inserts are Oil and Heat Resistant and can be reversed when worn on one side to double their long service life.

Write for Catalog No. P-110.

SPRING LOCK WASHER | VALVE INSERT PLATE | REVERSIBLE "DIA-TEX" VALVE INSERT | VALVE | VALVE SEAT



RED DEVIL VALVE SEAT PULLER

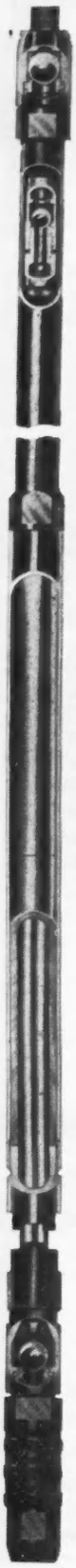
Provides a fast and positive means for pulling badly stuck valve seats by gripping the bottom rim of the seat. Eliminates the expense and hazards of removing seats with a cutting torch. All parts are made of highest grade alloy steel. Write for Catalog No. P-111.

CONSULT YOUR COMPOSITE. For full information on Red Devil Valves, Pullers and other Products, see Composite Catalog or write for price catalogs noted above. Red Devil Products are available through your supply store.

OIL WELL MANUFACTURING CORP.

6008 S. Alameda St., Los Angeles 1, Calif.

FOR TOP PERFORMANCE IN SMALL VOLUME WELLS



USE

O'BANNON MERCURY ROD PUMPS

A 1" bore, precision metal-to-metal pump, the Mercury is made to wear longer in wells where pumping conditions are tough. The Mercury is available in four types: Traveling Barrel Type (illustrated), Stationary Barrel Type with Top Hold-Down, Stationary Barrel Type with Bottom Hold-Down, and Stationary Barrel Type with Bottom Discharge Valve.

The Stationary Barrel Type with Bottom Discharge Valve is a new type and is especially designed for wells where sand or gas cause trouble. The pump has a solid plunger which increases compression ratio to prevent gas lock. Fluid is discharged just above the seating nipple, preventing sand from settling above the hold-down.

THESE FEATURES INSURE TOP PERFORMANCE

- **CRO-LAY PLUNGER—Gives maximum resistance to abrasion.**
- **HEAT TREATED LINERS—Resist wear and are easy to align.**
- **CHROMALLOY BALLS AND SEATS—Upper and lower valves are oversize, minimizing fouling. Made from abrasion and corrosion resistant materials.**
- **ANTI-MAG CAGES—Keep effect of lodestone to a minimum.**

You can depend on Mercury's for help when your little wells are big problems.

Sold by Supply Stores

Walter O'Bannon Co.

Tulsa 1, Oklahoma

SQUEAKS from the BULLWHEEL

Professional Man

"You've been promoted?"

"Yep. Used to be a drop engineer, and now I'm a sandwich engineer."

"What do you mean?"

"The boss used to come around and say, 'Drop whatever you're doing and do this.' Now he says 'Sandwich this in between whatever you're doing.' "

Dividend Declared

"You say a sweater is a good investment for a girl?"

"Yup. She gets out of it what she puts into it, and draws considerable interest besides."

Pattern

"Young man," said the old married man to a friend about to be wed, "you will find, as you give things to your wife, she will go through three stages."

"Really?" rejoined the lovesick swain. "That's very interesting. What are the three stages?"

"At first," came the solemn explanation, "she will say, 'You are the dearest, sweetest, most wonderful husband in the world.' Then, before you know it, you will find her accepting a gift with, 'Well, it's about time. I thought you'd never get it for me!' "

"And the third stage?" inquired the young man fearfully.

The older man sighed. "Then she'll say, but softly, and only to herself, 'He gave it to me without a struggle. I wonder what he's up to?' "

The Price of Justice

In the early days of the Old West, an old-timer was elected justice of the peace. As was usual in those days, he knew no law. When cases were brought before him, he would take out, with a flourish, a fine looking book, inside which he had fastened a Sears-Roebuck catalog. One day he thumbed the pages, put his finger on a point and said: "You are fined $4.98."

The defendant got up to protest. "Sit down!" the lawyer cautioned, pulling at his client's coat-tail. "You're just plain lucky he turned to Pants instead of Pianos."

Overdone

"I started out on my new job with a bang. I got to work ahead of time, and I pitched right in with everything I had to show them I was fired with enthusiasm for that kind of work."

"And how is it working out?"

"Before the week was over I was fired with enthusiasm."

The World We Live In

It's hard to realize that this country was founded partly to avoid taxation.

•

Sign in a restaurant: "We'll Try Not to Raise the Price of Your Lunch While You're Eating."

•

While nobody knows the exact age of the human race, everybody agrees that it is old enough to know better.

•

It is unfortunate that so many people seek something for nothing. It is even more unfortunate that they are getting it.

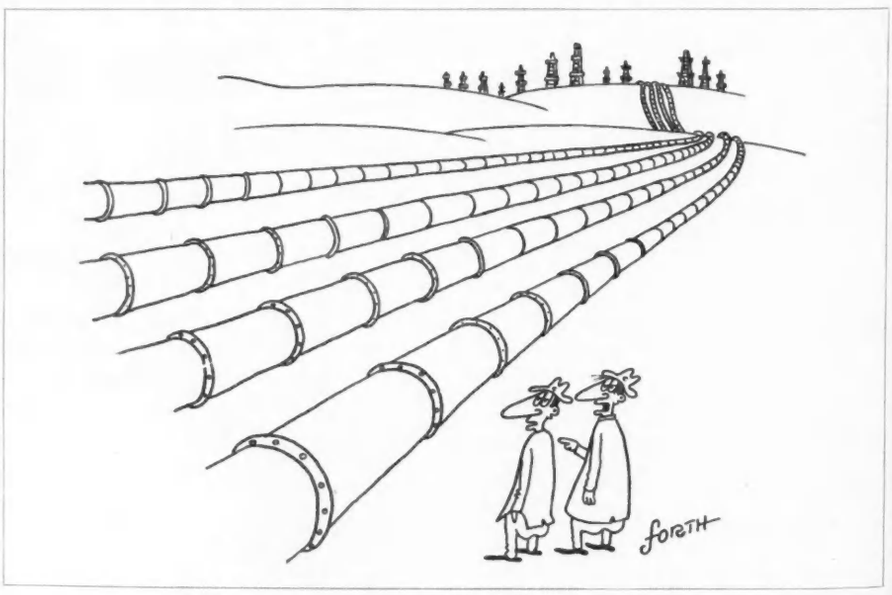
•

The U. S. Bureau of Labor Statistics solemnly announces that its recent survey reveals that women spend more money on clothes than men. We wonder how much of the taxpayers' money was spent to find out what every married man already knows!

Love's Labors Lost

A high school youth whose interest in girls shifted about every three or four days was charged by his parents with having a changeable disposition.

"Not me," replied the lad with some heat. "I don't change. It's the girls when you get to know them better."



"This one carries the oil to the refinery, and the others bring coffee from town to the men in the field."

What's NEW

In Perforating, Testing, and Fishing Tool Services

McCULLOUGH®
NEW SERVICES • NEW TOOLS
NEW WAYS OF DOING THINGS

Latest News About New Tools, Techniques and Services

You Get MORE Than

MORE OIL

With McCullough, World's Hardest Shooting, Gun and Jet Perforators!

MORE OF EVERYTHING — Judge for yourself by these excerpts from typical job reports from a few McCullough service branches:

– MORE THAN MORE OIL –

Ventura, California. You get record-breaking speed and efficiency, when you order McCullough perforating service. Saving valuable rig time is a MUST with all McCullough crews: 6140 McCullough Burrless Bullets shot in only 51 hours! 5718 McCullough Burrless Bullets shot in only 43 hours! 7188 McCullough Burrless Bullets shot in only 65 hours! 102 McCullough Glass Jet shots in only three hours!

– MORE THAN MORE OIL –

Edmonton, Canada. You get unmatched service because McCullough will go anywhere, anytime to do your perforating. In Canada, it is common for McCullough crews to fly hundreds of miles—in winter or summer—to bring fast, efficient service to remote wildcat areas. Perforating is accomplished without the need of electrical equipment, since McCullough Gun Perforators can be fired either mechanically or electrically—an exclusive McCullough feature!

– MORE THAN MORE OIL –

Fox, Oklahoma. You get more types of guns, more sizes of bullets, and the maximum safe charge of explosives in small pipe, where MORE POWER is needed. In this particular well, 4½" drill pipe was set due to the scarcity of casing. Ordinary jet perforators could not do the job, due to the small charge of explosives necessary in a small O.D. rigid body gun. The McCullough Glass Jet Perforator with a Steel Strip Carrier permitted the use of the maximum safe charge of explosives, resulting in a successful gas well.

– MORE THAN MORE OIL –

Billings, Oklahoma. You get the best perforating job possible, regardless of the size or number of casing strings in your well. On this particular job, one service company refused to attempt perforating due to the thickness of the casing, the number of strings, and the large amount of cement behind the pipe. This job, witnessed by representatives of four oil companies, was shot with the McCullough Glass Jet Perforator. Quantities of water were produced after perforating. Another service company attempted to perforate with a large open hole jet charge but failed to improve results.

– MORE THAN MORE OIL –

Houston, Texas. New McCullough Glass Jet Perforators now achieve .759% greater penetration, through solid steel plate, with .375% LESS explosives—by actual surface tests! In competitive tests no other perforator even approaches it! In addition to more oil this means less chance of damage to the casing in your well. Another improvement has been the use of a 50% stronger steel strip carrier, eliminating the possibility of debris.

– AND, OF COURSE, MORE OIL –

Reports from all branches and district offices have one thing in common—MORE OIL, even after all other methods fail to get results! These cases are too numerous to list, it would take pages. But here are only a few: 8 B/D to 256 B/D; 40 B/D to 180 B/D; 35 B/D to 225 B/D; 0 B/D to 950 B/D; 0 B/D to 1560 B/D potential; 8 B/D to 133 B/D; etc.

– WHY CALL McCULLOUGH? –

You are interested in what we or our tools can do for you. You will never know the many benefits of our service until you call us. McCullough Service Engineers are available in your area, for consultation on your perforating problems, and without obligation. They are oil men with the hardest shooting, deepest penetrating Gun and Jet Perforators in the world. These are production tools. If oil is there they will get more of it, and that is what you are after!

– WRITE FOR THIS CATALOG –

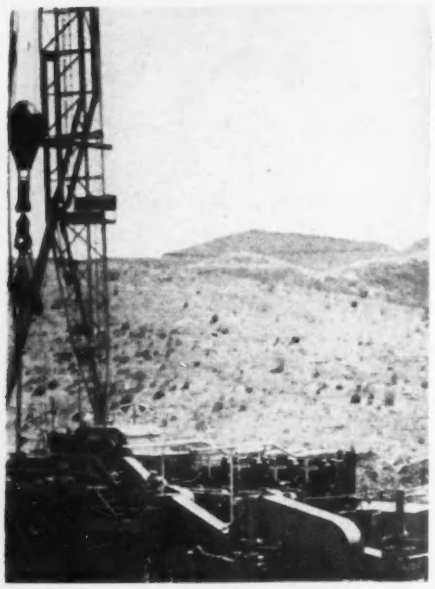
Write for your copy of the new McCullough Section of the Composite Catalog. Pages 3209 to 3223 are devoted to perforating. Factual information you need—illustrations, specifications, operating data, results. Send for your copy today.

PERFORATING, TESTING AND FISHING SERVICE ANYWHERE – ANYTIME!

McCULLOUGH TOOL COMPANY
5820 South Alameda Street, Los Angeles 58, California
405 McCarty Street (P.O. Box 2575) • Houston, Texas
CANADA: Edmonton, Alberta • **EXPORT OFFICE:** Los Angeles, California
VENEZUELA: United Oilwell Service Co., S.A.; Caracas, Anaco, Maracaibo

SERVICE LOCATIONS: TEXAS: Houston, Snyder, Alice, Cisco, Corpus Christi, McAllen, Odessa, Tyler, San Angelo, Victoria, Wichita Falls. **OKLAHOMA:** Oklahoma City, Guyman, Healdton. **MISSISSIPPI:** Laurel. **NEW MEXICO:** Hobbs. **KANSAS:** Great Bend. **WYOMING:** Casper. **CALIFORNIA:** Los Angeles, Avenal, Bakersfield, Ventura. **LOUISIANA:** Houma, Lake Charles, New Iberia, Shreveport. **COLORADO:** Sterling.

Mid-Continent NEWS and HUMOR?



HIGH IN THE MOUNTAINS—

near Ventura, California, a new "Baby" has been born in the oilfields—a "Baby" named the Mid-Continent Swinging Final Drive! The new offspring is a brother to Mid-Continent's famous Swinging Compound and is another "first" from the company's Engineering Department.

Eliminating the problem of sprocket alignment and connecting the chain between the compound and the drawworks, the new unit tremendously shortens rigging up operations. With these units, the only chain broken is the rotary chain. The Bell & Burden, Inc. rig shown above is the *first* anywhere to feature this new unit.

"Stop Clowning and Start Pumping!"

MID-CONTINENT Supply Company

General Offices Mid-Continent Bldg. FORT WORTH, TEXAS

SQUEAKS FROM THE BULLWHEEL

Home-Made

Elder Johnson of Squintberry Gulch says, "The President's speech of June 15 was so poor lots of folks think he must have writ it himself."

Discovery

Teacher: "What is ignorance, Gerald?"

Gerald: "It's when you don't know anything and someone finds it out."

Visiting Hours

Hubby sneaked home at 3 a.m. His angry wife met him at the door.

"So home is the best place after all," she snorted.

"I don't know about that," her mate replied, "but it's the only place open."

Applied Science

Engineering students are baffled by the fact that often the girls with the most streamlined shapes offer the most resistance.

Home Comforts

The patient was recovering from pneumonia. He repeatedly asked for food and finally the nurse served him a spoonful of rice. A few minutes later the patient called her and said: "Now I want to read a little. Bring me a postage stamp."

Secret Weapon

A saleswoman at the perfume counter was overheard explaining to a prospective customer: "This one has proved quite effective. It has a chloroform base."

The Test

Poise is that quality which enables you to purchase a new pair of shoes without seeming to be aware of the hole in your sock.

"You sure have a nice teeter-totter, Tommy."

Progress Report

"What did they teach you today?" the mother asked her little son after his first day in school.

"Not much," the youngster replied. "I've got to go again tomorrow."

Restriction

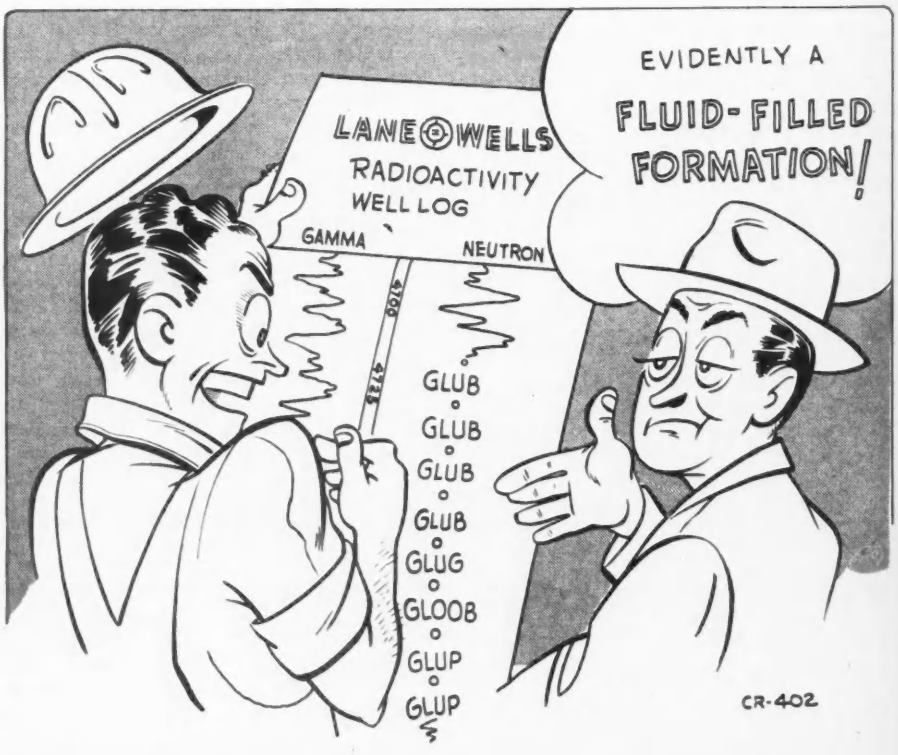
Lost on the Harvard campus, a visitor inquired directions of an undergraduate. The Harvard man apologized: "I'm very sorry, sir, but I'm afraid I can't help you. I'd have to point."

Old Routine

Sam: "I'd like to stop off and have a drink with you, but I have to go home and explain to the wife."

Joe: "Explain what?"

Sam: "How do I know? I'm not home yet."



HINDERLITER

TYPE HW TUBING HEADS

The Two-In-One and Four-In-One Type HW Tubing Heads are two of the most popular heads ever designed. A number of leases have been produced solely through Type HW Heads.

These Heads have full opening internal bore and are tested for 4000 p.s.i. Test Pressure and available in a full range of sizes.

The Type HW Two-In-One Tubing Head is designed for use in pumping production or flowing wells, when acidizing and for repressuring projects. Well tubing may be installed by slip suspension or hanger.

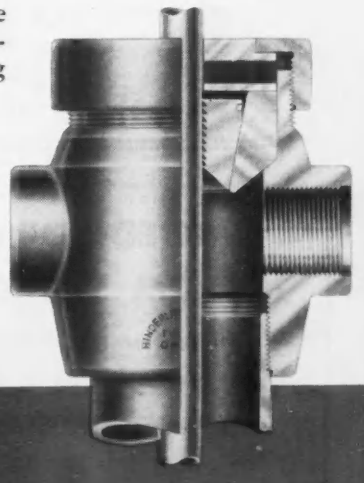
The Type HW Four-In-One Tubing Head using the same famous Two-In-One basic unit permits the holding of well pressure or fluid when running or pulling tubing.

Standard adapters for use on Type HW Heads permit the installation of Oil Savers, Valves and other customary production units.

Either unit is available with threaded or flanged bottoms.

The complete line of Hinderliter Tubing Heads comprises types to fit every production problem from high pressure flowing wells to pumping wells.

Write for Bulletin No. W-404R



HINDERLITER
PORTER
"Better Built"
EQUIPMENT

At Your SUPPLY STORES

HINDERLITER TOOL COMPANY DIVISION

H. K. PORTER COMPANY, INC.

TULSA 1, OKLAHOMA **DRAWER 2650**

BARRET

SPECIALIZING IN MAGNETIC SURVEYS

Contracts accepted for domestic and foreign projects, using the most improved instrumental and interpretative technique.

William M. Barret, Inc.

Consulting Geophysicists

GIDDENS-LANE BUILDING
SHREVEPORT, LOUISIANA

Standco
NO-SMOKE

STANDCO BRAKE LINING

Nothing novel—no bunk, but it gets the job done without scoring brake rims. See pages 3973-3978 Composite Catalog.

Standco Brake Lining Co.
HOUSTON

HOUSTON LABORATORIES
Analytical and Consulting Chemists

Hydrocarbon Gas Analyses, Reservoir Equilibria Studies for Crude and Condensate well, Waters, Brines, Corrosion and Industrial Analyses.

Phone CApitol 1319, Box 132, Houston, Texas

PRINTED FORMS FROM STOCK

Immediate delivery of producing and pipe line forms made from our complete line . . . Write for completely illustrated catalog.

GULF PUBLISHING CO.

P. O. Box 2608 Houston 1, Texas

SQUEAKS FROM THE BULLWHEEL

The Will and the Way

Lawyer, reading client's last will and testament to a circle of expectant relatives: "And so, being of sound mind, I spent every cent I had before I died."

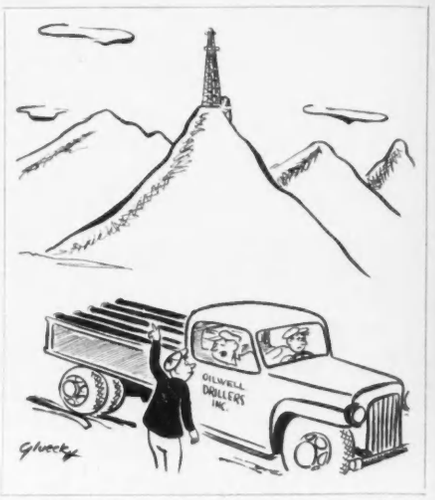
Famous Last Words

"I don't see how they can make any profit at a dollar a quart?"

"All I want is for you to marry me, honey. I don't care whether you can cook or not."

Duty-Bound

Small Girl: "Goodbye, Susie. Mama and Daddy are having company, and I've got to go home and make precocious remarks."



" . . . 'Ours not to reason why' . . . "

Sure-Shot

Two farmers at a county fair were fascinated by a booth where little celluloid balls bobbed on top of water jets. Customers were offered substantial prizes if they succeeded in shooting any one of the balls off its perch. One of the farmers spent six quarters in a vain attempt to pick off one ball. Finally his friend pushed him aside and picked up the rifle.

"Watch how I do it," he said.

He took a single shot. All six balls disappeared.

As they walked away from the booth laden with prizes, the unsuccessful one marveled.

"How did you ever do it?" he asked.

"It just took knowing how," explained the winner. "I shot the man who was working the pump."

(This One's a Sleeper)

"Who was that lady I saw you out with last night?"

"I wasn't out, I was just dozing."

For Complete Protection, Use

HERCULES

TUBING HANGERS

Because of the protection provided, no well should be "put on the pump" without installing a Hercules Tubing Hanger for suspending the tubing. All Hercules Tubing Hangers use the well known Hercules overhead packing arrangement. Made in all sizes to support up to 4" tubing. There is also available a Hercules type RH Hanger with means for packing off around both cable and tubing when used with Reda bottom hole pumps. To assure complete tubing protection, be sure to specify Hercules Tubing Hangers. Write for Bulletin.

HERCULES TOOL TULSA

Sold at all Supply Stores

HERCULES TOOL COMPANY

Manufacturers of Oil Field Equipment

General Office and Plant: 17th and Phoenix P. O. Box 286 — TULSA, OKLAHOMA — Telephone 3-1186 Cable Address "HERTOCO"

Export Representative: OIL FIELD EQUIPMENT CO., INC.
T. E. WARD, President
30 CHURCH ST., NEW YORK 17, N. Y.